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FINANCIAL ANALYSIS OF SALMON FARMING IN COASTAL BRITISH COLUMBIA

Economic and Commercial Analysis
Report No. 54

Fisheries and Oceans
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FINANCIAL ANALYSIS OF SALMON FARMING IN COASTAL BRITISH COLUMBIA

A Computer-Based Model Approach

Economic and Commercial Analysis Division

Program Planning and Economics Branch
Department of Fisheries and Oceans
Suite 400 - 555 West Hastings Street
Vancouver, B.C.
V6B 5G3

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Report Prepared by:

Brian D. Egan, Heather M. Egan and Bruce F. Wright of
NEW PACIFIC VENTURES, Vancouver, B.C.

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ABSTRACT

A computer model of fish farming economics has been developed for use as a planning tool for the Department of Fisheries and Oceans. With this model, all factors that affect the cost of production and farm viability can be altered to permit "what if" and "sensitivity" analyses to be performed.

This report provides a detailed explanation of the factors that determine the cost of production and affect a farm's viability. The reader is guided through a series of program modifications which, in addition to describing several likely salmon farm scenarios, demonstrate how to use the program to simulate still other operating scenarios.

A standard farm is used to illustrate how operating decisions (changing program variables) affect farm viability and the cost of production. The standard farm is not "average" because a high degree of variation within the industry prevents the "average" from being defined. Instead, the standard farm is defined as: 50 percent financed through debt, well financed for capital purchases, having transport costs similar to the Campbell River area, of a moderate size, having only one farm site, having good management, and raising monosex feminized chinook salmon and accelerated coho salmon in the same numbers each year.

For a copy of the farmed salmon model contact Peter Leitz at (604) 666-6570.

RÉSUMÉ

Un modèle informatisé d'analyse de l'aspect économique de la salmoniculture a été conçu comme outil de planification pour le ministère des Pêches et des Océans. Dans le cadre du modèle, on peut modifier tous les facteurs qui influent sur les coûts de production et la viabilité des piscifactures afin d'analyser diverses hypothèses et leurs conséquences.

Les auteurs du rapport expliquent en détail les facteurs qui déterminent les coûts de production et influent sur la viabilité des piscifactures. Dans le rapport, le lecteur est amené à manipuler les variables du programme, ce qui lui permet de voir plusieurs scénarios d'exploitation courants et d'apprendre à utiliser le programme pour simuler d'autres scénarios.

La notion de "piscifacture type" est employée pour illustrer comment les décisions sur le plan de l'exploitation (c.-à-d. la modification des variables du programme) influencent la viabilité de l'installation et les coûts de production. Cette piscifacture type ne représente pas une installation "moyenne", car les établissements varient tellement à l'échelle de l'industrie qu'il est impossible d'établir ce qui constitue une piscifacture "moyenne". L'installation type se définit comme une piscifacture bien gérée, d'importance moyenne, qui comporte un seul parc d'élevage, est financé par emprunt à 50 %, dispose d'un financement suffisant pour les achats d'immobilisations, présente des frais de transport semblables à ceux des pisciculteurs de la région de Campbell River, et élève chaque année un même nombre de saumons quinnats du même sexe (obtenus par féminisation) et de saumons cohos à croissance accélérée.

Pour obtenir une copie du modèle d'analyse de la salmoniculture, veuillez communiquer avec M. Peter Leitz au numéro (604) 666-6570.

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Numerous people contributed time and information that assisted in the preparation of this document. The financial information presented is a mixture of the data obtained from these parties and from the experience of the authors as fish farm operators and consultants. The results therefore do not reflect the operating performance of any one contributor.

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INTRODUCTION

This report describes the results of a computer based analysis of the economics of farming salmon in net-pens, in the coastal waters of British Columbia. It is based on a computer model that was modified to meet the needs of planners and analysts in the Department of Fisheries and Oceans. The program is designed to permit "sensitivity" and "what if" analyses, on factors that affect the viability of salmon farming in British Columbia.

The program is written in the LOTUS spreadsheet environment. (The file name is "standard.wk1"). Any IBM compatible machine, with 640k of RAM, will support the software. The text that follows assumes that the reader is familiar with financial modelling and LOTUS.

The report has been divided into two main sections. The first is a detailed description of the computer model and its inputs and variables. Each variable, and set of calculations, is explained in terms of how it is generated, and how the results may be interpreted. Much of the value of this report comes from the discussion of variables and how they interrelate, both in the program and in reality.

The second section of this report provides step-by-step examples of how the program can be used to simulate different operating scenarios. The development of progressively altered operating scenarios provides meaningful results, and at the same time acts as a tutorial in the use of the program.

The detailed description of the program is centred around a sample farm of moderate size that is well run and reasonably successful. A printout for the "standard" farm is provided in this report, and the reader is expected to refer to this printout while reading this report.

As with any attempt to simulate reality, the program has limitations. The nature and extent of these limitations are discussed, with reference to how they may be avoided and how they affect results generated by the model.

The last set of analyses explore the effects of species and sexual treatment on cost of production. The patterns of growth and reproduction (life history), of the numerous types of fish being farmed in British Columbia is a major source of confusion and the root of much of the poor operating performance to date. The authors believe that a general lack of understanding or knowledge of the effects of life history patterns on production costs and revenues is the single most important factor affecting financial viability. It is argued that clarification of what type of fish to raise and how is the assistance most desperately needed by the industry.

This report, and the program it is based upon, address the economics of the salt water phase of salmon farming. The fresh water phase, which takes place in "hatcheries", is comparable to the salmon enhancement sector of the commercial fishery. Either type of hatchery produces "smolts", which are young salmon, ready to enter salt water, from fresh.

The smolts are sold to farmers by commercial hatcheries, or released by government hatcheries. The separation in production costs between the hatchery sector of the industry and the sea pen sector is therefore a natural one. The fresh water phase of the salmon farming industry has benefited from experience gained in government hatcheries, and, therefore, has not suffered as many "growing pains" as the salt water phase.

A special effort has been made to define the terms used in the report. For example, the term "feed conversion rate" has three working definitions. The first is the conversion of feed to fish, on an individual basis (the biological conversion rate). The second is the conversion of feed to fish for an entire population over time. This factor considers losses due to mortalities (the biological conversion efficiency). The third possible definition is the conversion of feed to marketable flesh for an entire population, throughout its production life. This factor considers both mortalities and weight losses due to processing (economic conversion rate). The possibilities for confusion in the industry, as a result of numerous definitions, are illustrated with examples.

STRUCTURE OF THE PROGRAM

The program contains production statements, financial statements and statements summarizing input and output variables and statistics. These statements are further divided into pages which are described in detail below.

The core of the program is the production statement which contains information relating to the biology of the fish being grown. Columns of data on size, mortality rate and feed conversion rate for each month are the inputs to the functions which calculate the amount of fish to be produced from a given number of smolts. The production information, in turn, forms the core of the financial statements.

The production and financial assumptions can be altered by the user in the variables section by changing inputs -- or factors affecting inputs. These may work through the production statements or through the financial statements. More complex changes, such as changing the species farmed, may require the user to replace an entire column of data, such as the size of the fish in each month.

A diagram, or map, of the structure of the program is provided on the following page. The program is a single large spreadsheet that has been divided into "range names", or pages. Navigation within the spreadsheet is greatly assisted by the use of the "GO TO" function key, in combination with the range names indicated on the map. The user may wish to keep a copy of the map at hand.

Appendix I is a printout of the results for the standard farm. The page names on this printout correspond to the range names provided on the map. The page names (eg. VARIABLES-3) can be used for navigating and for printing results on 8.5 x 11" paper, with a dot matrix or laser printer. The page names and not page numbers are used for reference throughout this report.

The map shows that the model has been broken into 7 broad regions covering twenty-two pages of actual printout. The first three pages (VARIABLES-1,VARIABLES-2 and VARIABLES-3) correspond to the ranges of the same name, and provide a listing of the production inputs (factors) that may be altered by the user. On the same pages are outputs of statistics that enable the user to alter, recalculate and then quickly see the effect of such alterations. Thus, it is simple, to input recent information or to predict the effect of changing assumptions or changing technology etc., on the results for the farm.

The pages named CHIN1 to CHIN4 and COHO1 to COHO4 are production statements for feminized chinook salmon and accelerated coho salmon (coho smolts produced in heated hatchery water), respectively. Some of the columns of production data presented here are raw data and some are calculated from the raw data. The production statements will vary with alterations made in the "factors" listed on the VARIABLES pages, as will be described.

To aid in the understanding of this report, readers will want to distinguish between "factors", "variables" or "statistics". The term "factors" refers to inputs appearing on the three VARIABLES pages, that are likely to be changed by the user. These factors may be altered at will, to simulate different operating and cost scenarios. The term "statistics" refers to outputs that appear on the same pages. These statistics will vary according to the values set for the "factors". Other "variables" within the production statements (such as: growth increments, mortality and feed conversion rates), are less likely to be changed. Unlike the majority of the spreadsheet, these variables are not protected from editing because they must be altered when modelling fish of a different variety, or with different stocking dates.

The pages named SOURCES-1A,-1B,-2A and -2B on the map, are all part of the "Sources and Uses of Funds" statement. This statement summarizes spending and revenue estimates over time. The statement has been subdivided into four ranges within the spreadsheet, to enable printing on standard-sized paper.

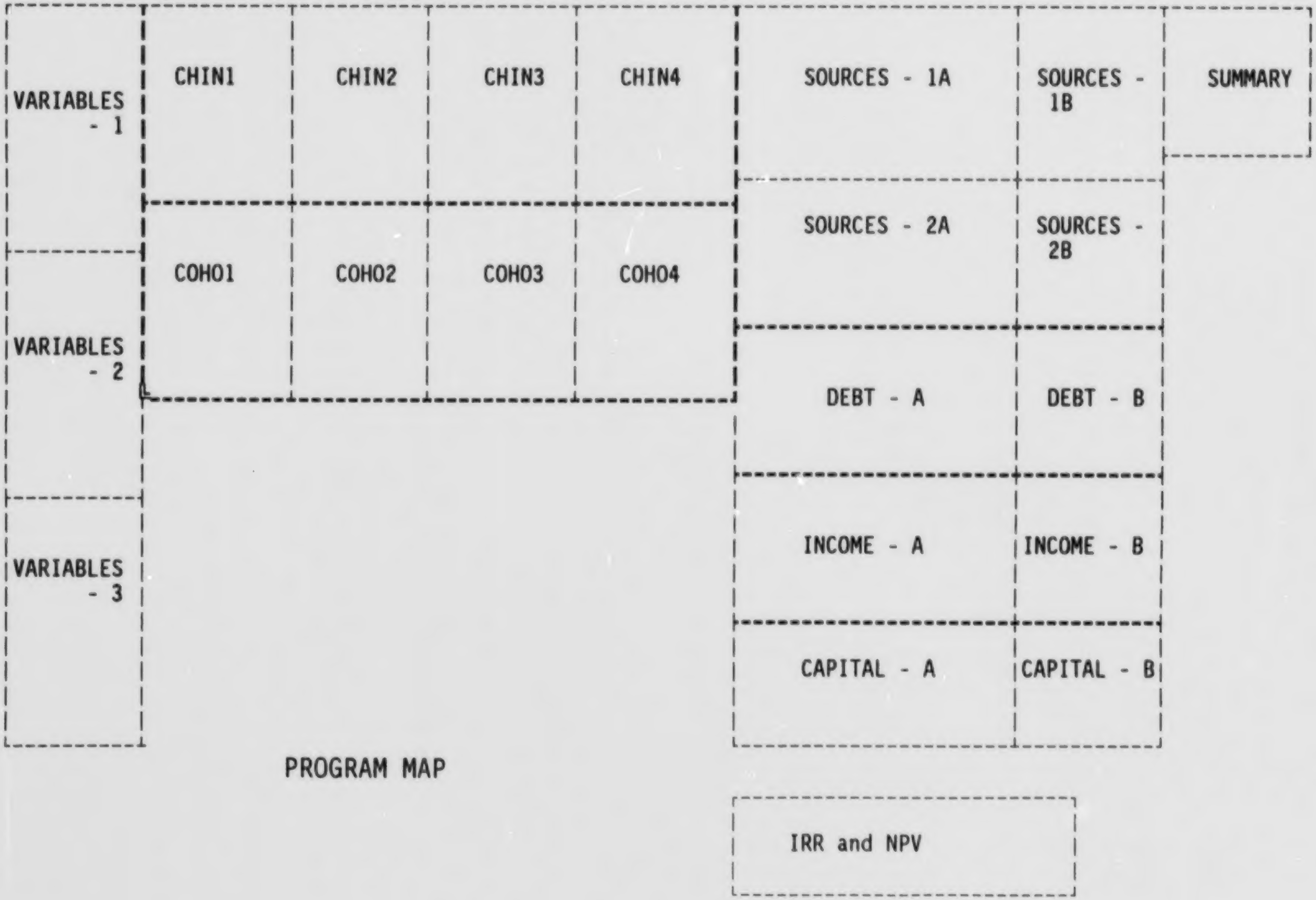
The ranges named DEBT-A and DEBT-B provide details of the way in which interest charges and principal repayments are calculated for the loans that are assumed to be available to the farm.

The ranges named INCOME-A and INCOME-B, together, constitute the income statement for the farm being modelled.

The ranges named CAPITAL-A and CAPITAL-B provide details of the calculations for capital cost allowance deductions.

The range labelled IRR as an NPV has not been printed out. In this range, or location in the spreadsheet, the calculations of internal rate of return and net present value take place. The resulting statistic are reported elsewhere.

The last page of the printout is the SUMMARY. It provides a brief description of the farm being modelled, as well as critical statistics. In the second section of this report, dealing with scenarios other than the standard one, only the SUMMARY range is presented.


VARIABLES - 1
VARIABLES - 2
VARIABLES - 3
CHIN1
CHIN2
CHIN3
CHIN4
COHO1
COHO2
COHO3
COHO4
SOURCES - 1A
SOURCES - 1B
SUMMARY
SOURCES - 2A
SOURCES - 2B
DEBT - A
DEBT - B
INCOME - A
INCOME - B
CAPITAL - A
CAPITAL - B
IRR and NPV

PROGRAM MAP

DESCRIPTION OF THE PROGRAM'S ASSUMPTIONS, STRUCTURE AND INPUTS

The following discussion provides a detailed description of the assumptions and inputs on which the model is based. The discussion works through each set of calculations, and is therefore a good reference for later use.

To illustrate the model, a "standard" farm has been used. The "standard" farm is meant to simulate a well financed, medium-sized farm, with all feed storage and accommodation facilities located on a single barge adjacent to floating net pens.

A fundamental assumption of the model is that the same species, in the same numbers, and under the same conditions, are raised each and every year of the forecast period.

The discussion of the model is broken down into sections according to the different statements contained within the model. These statements are:

PRODUCTION STATEMENTS
STATEMENT OF SOURCES AND USES OF FUNDS
STATEMENT OF DEBT SERVICING CALCULATIONS
STATEMENT OF CAPITAL COST ALLOWANCE CALCULATIONS
INCOME STATEMENT

Each statement is discussed both in terms of how the data is presented, and how the numbers generated were derived by the program. Since the VARIABLES pages contain the factors that determine the timing and magnitude of costs and revenues, it is necessary to make constant reference to the VARIABLES pages, in order to explain the model. As stated above, the variables on the VARIABLES pages are generally referred to as "factors", in order to differentiate them from the variables that appear on the production statements, which are not meant to be altered as routinely.

PRODUCTION STATEMENTS

There are two sets of production statements. One set represents the expectations for rearing feminized chinook (CHIN1 to CHIN4), and the other for accelerated coho (COHO1 to COHO4). The formats of both sets of statements are identical, as are the ways that calculations are made. Therefore, the discussion of production statements will encompass both species. The differences between them will be explained to provide an example of how production costs differ between species.

The production statements could be a single, wide page of printout, but, to allow for the use of letter-sized paper, they have been divided into four pages. Each page includes TIME information to permit use as an independent reference source.

The production statements are based on the analysis of a single year class of each of the two species. The growth increments, mortalities and feed consumption are all tracked, on a monthly basis, throughout the life of a fish stock.

Knowing the production requirements and life history of the fish allows the program to forecast the farm's production, capital and financial needs for the following years when production cycles overlap. These needs will be discussed and illustrated, with the example of the sea pen requirements, later in the text.

The monthly costs and revenues generated by the production statement portion of the program are presented on a quarterly basis on the financial statements. At the end of three years of analysis, forecasts are made on an annual basis. This allows for the longest production cycle to be reported on a quarterly basis and ensures that full production is reached before annual summaries of data begin.

PAGES - CHIN1 AND COHO1

TIME

1. Month
2. Quarter
3. Year

The standard farm is presumed to begin operations on January 1 of year one. Fish are first introduced into the farm's net pens at the end of April, of year one, when feminized chinook smolts become available.

The January start-up allows several months before fish arrive for installation of pens and nets and other preparation required for the start-up of a farm.

BIOMASS

4. Number Remaining at end

Column four of the production statements provides a running total of the number of fish that remain after sales and mortality losses. The first number in the column is the number of smolts that are initially stocked (150,000 for chinook, and 100,000 for coho). The row in which the first number appears indicates the date of stocking in the pens. All statistics report data for the end of a given month, and therefore the chinook were stocked at the end of April and the coho at the end of June.

The standard farm is assumed to have received relatively good quality smolts. That is, they arrived early and at a large size. Poorer quality smolts than those described might arrive at the same weight, or even smaller, anywhere from 1 to 4 months later. A late arrival ultimately results in a shorter growing period, loss of optimal temperature regime for growth and consequently, sales at a lower average weight.

The number of chinook or coho smolts stocked on the farm is entered on line 1 of VARIABLES-1 page. Changes in the scale of a farm are made by changing the number of smolts stocked. Within a reasonable range, the program will automatically alter production and overhead costs to reflect the change in scale.

To minimize typing by the user, the month in which smolts are assumed to be stocked on the farm results automatically, from when the first growth increment appears in column 5a. The number of smolts stocked, as determined on VARIABLES-1 page, will appear in column 4 in the same month that a number larger than zero appears in the adjacent cell in column 5a. The first growth increment in column 5a is meant to be the average weight of the smolts when they arrive on the farm. Production costs are then calculated from the beginning of the following month.

5a. Real average weight

Column 5a reports the average weight of individual fish in a given stock, at the end of each month.

The numbers in column 5a are variables and are not protected from editing because they must be altered if a different variety of fish is to be modelled, or a different growth curve is to be used.

The first number in column 5a (7 grams, for the chinook) indicates the average weight at which the smolts arrived on the farm. The month in which the first number appears (April) triggers the calculation of production costs beginning in the following month.

5b. Average weight used

Column 5b is the average weight of individual fish used in later calculations. The numbers in 5b are the product of 5a and the "GROWTH AS PERCENT OF ASSUMED" factor on line 4 of the VARIABLES-1 page. Including "real" and "used" average weights, makes the growth curve variable, permitting uncomplicated "what if" analysis. Changing the factor allows the analyst to alter growth rates up or down, while leaving the basic growth curve intact.

6. Growth in percent

Column six is included as a measure of the increases in average weight (column 5b) that have been assumed to occur between various months. A level of 86% implies that the average weight in column 5b, at the current month-end, is 86% higher than in the previous month.

An inspection of the numbers in column 6 will illustrate that small salmon grow faster, on a percentage basis, than do larger salmon, and that the warmer months provide more rapid growth than do the colder months. The actual magnitude of these differences depends on a number of environmental factors and on the species involved.

7. Biomass at end

Column 7 reports the month end biomass of a single year-class of the stock being considered.

The value for the total biomass at end, is derived from the product of the average weight (5b) and number of fish remaining (4) for any given month.

MORTALITY

8a. Real mortality rate

Column 8a reports the mortality rate that is anticipated to occur during a given month. To calculate the number of fish, and the biomass lost, the percentage mortality indicated for a month is subtracted from the number of fish remaining at the previous month-end (column 4). Since the percent mortality affects a diminishing number of fish, the same percentage has a decreasing effect over time.

The mortality rates reported for the chinook start with a 5% loss. This is a conservative estimate of the losses that can occur due to the smallest fish escaping from a net, or from cannibalism. These losses are typically referred to as unexplained losses and have accounted for as much as 50% of some farmers' stocks. A low percentage of unexplained losses has been assumed, because improvements in smolt quality and counting techniques appear to be eliminating the problem.

It has been assumed that the coho will suffer initial losses of 15%. This is a conservative estimate of losses due to non-smolting and to unexplained losses. Non-smolting results from the fact that not all individuals in an accelerated population will be large enough, or physiologically ready to enter salt water.

The occurrence of non-smolting, where the fish is not properly adapted for life in salt water, can be as high as 80%, and has resulted in tremendous losses for some farmers. This is a decreasing problem as the quantity and quality of smolts available to the industry is improving. For the purposes of this model, it is assumed that all non-smolts are destroyed.

Relatively high summer mortality for both species is due to anticipated Vibrio losses. In general, Vibrio is not considered a serious threat to farmers, because it can be effectively treated with antibiotics, and its occurrence can be minimized by good husbandry practices.

Fall and early winter are usually a healthy period because of falling, and then low, temperatures. However, Bacterial Kidney Disease (BKD) picks up in late winter. BKD appears to thrive at temperatures between 10 and 14 degrees celsius, and therefore hits hardest as the waters begin to warm in the late Winter and early Spring. BKD losses tend to subside by late Spring but can occur at any time.

It is generally agreed that BKD is a very serious threat to farm viability. It is not easily treated, because water soluble antibiotics cannot reach virulent cells that lie within body fats. Outbreaks of BKD can be suppressed by expensive antibiotic treatments, but the pathogen remains. Once BKD is in a stock of fish, there tend to be constant, low level losses. These losses eat away at profits because they are not insurable, and because the fish may have to be downgraded or discarded upon harvest.

Other, and possibly new, diseases could impact on specific farms. Good husbandry, especially keeping stress levels low, is generally considered to be the best defense against this source of mortality.

Losses due to early sexual maturation or jacking of some of the male fish in a population can also be devastating. Jacking occurs in both coho and chinook populations, but is not a problem for accelerated coho because they are too small during their first Fall in the sea, and are sold before the second.

Jacking in chinook salmon is a very serious problem. Losses due to jacking can radically increase the cost of production on a farm, and affect its viability. Feminized fish were developed to eliminate jacking and are considered most desirable for this reason.

For regular sex chinook, jacking occurs in their second Fall in the sea, after 17 months of growth. The "jacks" in a population are usually the largest members of a population at this time. While the average weight of the non-jacking population may be 1.2 kilograms, the jacks could average 3 kilograms in weight. The death of these fish represents a sizeable financial loss.

Two strategies have developed to deal with jacking. The first is to try and sort, or "grade out", the jacks from the population and sell them at the prevailing market rate.

Grading out jacks typically involves removing the largest fish from a population, on the assumption that they are the ones that will jack. While, the value of the salmon declines significantly if jacking begins, size grading presents two problems. First, it removes the largest non-jacks. These would have been the most valuable production fish a year later. Second, size grading does not prevent losses from small fish which may jack later.

In the past, some farmers have chosen to live with jacking losses because the "stress" to the remaining fish, from handling during grading, was considered to be too costly in terms of potential losses later. However, jacking rates of as much as 40% have forced most farmers with regular sex fish to attempt some method of dealing with this problem.

While some farmers believe that the harvesting of jacks is an acceptable obligation, most would prefer to avoid the necessity. This sentiment is reflected in a growing demand for feminized chinook.

Feminization is the second strategy that has been developed to combat jacking. There are techniques for both hormonal feminization, and feminization through the use of monosex milt (sperm from masculinized females which have chromosomes to produce females only). It is generally agreed that hormonal feminization is undesirable because it slows growth. Monosex milt feminization is, however, considered very successful. The monosex stocks appear to grow as fast as the non-jacking portion of the regular stocks, and have similar mortality rates.

Monosex chinook were used as one of the stocks in the standard farm because they represent a large, and growing, percentage of the fish being farmed.

While accelerated coho essentially all jack, they reach marketable size before jacking occurs. The coho usually become sexually mature just before the chinook, and therefore must be sold before this time. Consequently, they have a very short production window of 13 to 15 months, which makes it difficult to attain average weights in the profitable 4 to 6 pound range.

High, chronic mortality for the chinook, in their second winter, is the result of limited jacking and BKD. Some jacking occurs even in feminized stocks, and BKD is always worst in a stock's second year.

Overall, mortality rates of around 30% for the two species are considered average. However it is important to recognize that early losses, such as those from non-smolting, are much less of a problem because the incurred costs, particularly in feed are much less than for later losses.

8b. Mortality rate used

Column 8b is similar to 5b in that it is in place to permit "what if", or sensitivity analysis, to be performed on mortality rates. Line number 5 on VARIABLES-1 page allows the analyst to alter the mortality rate used in later calculations without having to change a series of numbers. These changes increase or decrease all monthly rates evenly.

9. Number lost

Column 9 reports the number of fish that would die as a result of the mortality rate provided in column 8b.

10. Biomass lost

Column 10 reports the biomass lost for a given month. It is the product of the number of fish lost in a month and the average weight at the end of that month.

The biomass lost is used in later calculations to derive the conversion rate of feed to marketed flesh. It is also an indication of the quantity of dead fish that must be disposed of on the average farm.

11. Percentage mortality to date

Column 11 provides a running total of the percentage of the original number stocked that has been lost as of the end of a given month. The highest number in this column represents the overall mortality rate that has been assumed to occur for each of the species.

For both chinook and coho, the cumulative mortality for the standard production plan is approximately 30%. However, as described, the chinook losses are more expensive than the coho losses, because they occur later in the production cycle. One half of the coho losses occur during the first month, and therefore only the balance of 13% represents fish that have received considerable investment in feed and other inputs.

Clearly the later that a mortality occurs in the production cycle, the more expensive it is. Therefore, the shorter production cycle of the coho has a lower risk factor and better "averages" than does the chinook, but farms raising coho have a smaller average size product and a more limited set of marketing options. The growth and survival performance of coho has also been erratic, resulting in additional risk for coho farmers.

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FEED COSTS

12a. Real feed conversion ratio

Column 12a gives the biological feed conversion rate that is assumed to occur during a given month. A number of 1.2 implies that 1.2 kilograms of feed are required to generate 1 kilogram (round weight) of growth.

Column 12a is not protected from editing, to permit the analyst to make changes in feed conversion rates that would be appropriate for modelling different species, or an alternative start-up date of the farm.

The ability of fish to convert feed to flesh decreases with increasing size. This pattern is indicated by the increase in conversion rates as the fish grow.

The efficiency with which feed is converted to flesh is also species dependent and is affected by temperature. The conversion rates that have been assumed include consideration of these factors. The monthly conversion rates are similar to those experienced by active farmers.

Feed conversion rates are also affected by husbandry practices. The use of automatic feeders is generally believed to increase the conversion rate because the machine is not observing the behaviour of the fish and will not stop or alter its feeding rate accordingly. The conversion rates assumed reflect those experienced by a farm that uses hand feeding. Variations of as much as 15% higher and lower have been reported by farmers.

12b. Feed conversion rate used

Column 12b is included to permit sensitivity analysis on the conversion rate used to calculate feed costs. Line number six on the VARIABLES-1 page provides a factor that when multiplied by column 12a produces the numbers that appear in 12b. The numbers in 12b are then used in later calculations. An increase in the "CONVERSION RATE AS PERCENT OF ASSUMED" factor of 10% (from 1 to 1.1) implies that 10% more feed is required every month to generate the same biomass increases that have been assumed to occur.

13. Overall conversion efficiency

Column 13 reports the overall efficiency with which feed has been converted to flesh that remains alive in the nets, or has been sold. This number is the conversion rate of feed to fish in-the-round, after considering losses due to mortalities.

The overall conversion efficiency is significantly higher than the conversion rate for any given month because of losses due to mortalities. An ending rate of 2.1 for the chinook implies that it takes 2.1 kilograms of feed to produce one kilogram of fish in-the-round. This is often a surprising result to farmers who only recognize this fact after a harvest is completed.

It is also important to understand that the conversion efficiency for marketed fish (best described as the economic conversion efficiency) will be higher still. Weight losses during processing, of 11% to 20%, increase the effective conversion rate still more. With processing weight losses of 11%, the feed conversion rate to dressed fish weight (market weight) becomes 2.36 for the chinook and 2.17 for the coho. (These statistics are among the numbers on VARIABLES-1 page.)

Increases in the effective conversion rate, with mortalities and then processing, are often ignored by people doing rough estimates of the cost of production for farmed fish. A conversion rate of 2 is often used as a "conservative" figure because the conversion rates for individual fish and for the farm as a whole are being confused. To be conservative, an overall conversion rate of 2.5 should be used.

To clarify, there are actually two types of conversion efficiencies which must be recognized. These are: biological and economic conversion efficiencies. Biological conversion has, in this text, been further classified to distinguish between the biological conversion rate of feed to living flesh on an individual fish basis, and the biological conversion efficiency of feed to living flesh on a population basis (i.e. after considering losses due to mortalities). The individual biological conversion rate is an input to the model while the biological conversion rate on a population is an output since it varies with the mortality rate. The economic conversion efficiency is a measure of the conversion of feed to marketable, processed flesh.

14a. Actual cost of feed per kilogram

Column 14a reports the cost of the feeds that have been assumed to have been used to achieve the growth and conversion rates reported in earlier columns.

Feed quality and price vary a great deal. It is presumed that growth rates and mortality are different for different feeds but the exact relationships are unclear. The feed prices assumed for the standard farm represent average prices.

There are essentially three types of feed being used on a production basis, at the present time. The cheapest is a steam cooked, dry pelleted feed that averages about $1.05 to $1.15 per kilogram, depending on the manufacturer and whether or not the feed contains pigments.

The top of the line production feed is referred to as extruded. Extruded feeds have a high oil content (over 20%) and are referred to as high energy feeds. The extrusion process does not require steam and allows for the production of a pellet containing more oil and better carbohydrates than the cheaper feeds. The extruded feeds cost around $1.35 per kilogram, depending on the manufacturer and the quantities purchased.

The third type of feed is a mixture of the previous two. It has been manufactured in response to demands for an intermediate energy level feed, and to growing concerns that the Pacific salmon may not be able to make full use of the high energy, fully extruded feeds. The semi-extruded feeds cost approximately $1.20 per kilogram, depending on manufacturer and volume.

Other varieties of feed are on the market, but are not yet in use in significant quantities.

The feed prices used in the standard farm model are based on feeding practices recommended by the manufacturers. They recommend high energy feeds ($1.35) for the first year of growth, when the young fish can make use of the extra oils. Entering the first summer, when the volume of feed rises rapidly, they recommend switching to the lower energy, semi-extruded feed ($1.20).

The conversion rates and mortalities assumed for the standard farm reflect the use of top quality feeds.

Feed prices are not expected to increase over the next year, but the future is uncertain. Prices have jumped twice in the last two years as a result of world wide increases in the price of fish meal and other ingredients. While new sources of fish meal are being developed all the time, the demand for protein, in all types of agriculture, appears to be growing more rapidly. Feed companies do not foresee a price decrease in the near future.

14b. Cost of feed per kilogram used

Column 14b is provided to allow the analyst to change the price of the feeds throughout the production cycles, by changing only one number. The factor labelled "FEED PRICE AS PERCENT OF ASSUMED" provides a factor for each fish stock that, when multiplied by all feed prices in column 14a, generates the prices that appear in column 14b. The prices in 14b are then used in later calculations to derive the total feed cost.

The feed cost factor can be used for sensitivity analysis on overall feed price changes or in analyzing the combined effects of multiple changes. Using it in conjunction with the feed conversion factor allows testing of how lower feed prices, coupled with higher conversion rates, affect the cost of production. Thus, the impact of using differently priced, different quality feeds can be assessed.

15. Weight of feed consumed

Column 15 reports the weight of feed consumed, calculated as the feed conversion rate used (column 12b) times the growth increment for a given period (column 5b) times the number of fish remaining (column 4) at the beginning of the period being considered (i.e. the number from column 4 which is one row above the row for which calculations are being made). This calculation assumes that mortalities are reared until the end of each month and then lost, and therefore provides a high (conservative) estimate of feed costs.

The weight of feed consumed for a given month is a good indication of the amount of work involved in fish farming and the logistic problems that develop. With two species and overlapping production cycles, the standard farm will consume upwards of 80 tonnes per month. This feed will be in several different pellet sizes for the different sizes of fish, and must be stored and rotated in and out of inventory. Its not surprising that fish farmers always seem busy.

16. Feed costs for each month

Column 16 is the product of the feed consumed during a month (column 15) and the cost per kilogram of feed during that month (column 14b). It provides a total of each month's feed bill.

To get a quarterly feed bill for the entire farm, the feed bill for each month, species, and year class must be summed. A total of nine cells for each stock must be summed, to arrive at the quarterly feed bill that appears in the statement of SOURCES AND USES OF FUNDS.

The column total, appearing at the bottom of the page, represents the cost of feeding one year class, of one stock of fish, throughout the entire production cycle. Because the same production cycle is assumed to occur each year, after full production is reached, the total for each stock is spent each year.

HARVESTING

17. Number of pieces sold

The timing of fish sales is difficult to model because each variety of fish has a unique marketing window as a consequence of growth rates, stocking dates and the onset of sexual maturity. Currently, the markets for farmed salmon prefer larger fish, and as a result, the salmon farming industry is geared for the production of fish weighing over two kilograms or, preferably, much larger. There is a significant price break between fish falling in the 2 to 4 pound size class and those falling in the 4 to 6 pound size class. The model has been designed on the premise that fish stocks will be raised until a certain minimum average weight has been reached, and then sales will begin.

To give the analyst the ability to change the weight at which fish are harvested, a factor for the "AVERAGE WEIGHT AT WHICH HARVESTING BEGINS" has been included on line 2 on VARIABLES-1 page. This factor instructs the program to automatically begin selling fish when the average weight in the middle of a month exceeds the factor chosen.

The factor for when sales begin is used with the factor of "PERCENTAGE SOLD EACH MONTH" that appears on line 3 of the same VARIABLES page. Once the average weight of a given stock has exceeded the factor on line 2, the decision must be made as to how fast to sell the remaining fish. The "percentage sold each month" factor determines the rate at which the fish are sold.

The "percentage sold each month" is the fraction of the number of fish remaining (column 4) which is sold in the first month in which the hurdle weight is reached. The same number of fish are sold in each subsequent month until the harvest is completed.

The factor for determining when the chinook harvest will begin has been set at 2.1 kilograms for the standard farm. This implies that the average weight must exceed 2.1 kilograms in the middle of a month before harvesting will begin. The hurdle weight is reached in February of year three, as indicated by the appearance of numbers in column 17 (number sold).

The factor for the percentage sold each month, is set at 20%. This means that 20% of the number remaining in February are sold in February, and the same number is sold in each of the following months until the harvest is complete. The last month of the chinook harvest (June) has fewer fish being sold than in earlier months, due to mortalities since the beginning of harvest.

A factor of 20% for the "percentage sold each month" implies that the harvest will occur over a five month period. The factor for the coho harvest is set at 50%, implying that the harvest will occur over a two month period.

The differences in the hurdle weights and speed at which the harvests occur, for the chinook and coho stocks, are a consequence of differences in the life histories of the two species. A farmer attempts to raise each stock to a large average weight, but only has a certain number of months to do so before the onset of sexual maturity, the associated disfigurement of the fish, and the subsequent loss of value.

The chinook has a maximum growing period of 30 months in the sea, whereas accelerated coho have only 15 months. Faster growth rates for the coho, however, make it possible to achieve reasonably high average weights within the 15 month production window. The high average weights are only achieved just before the onset of sexual maturity, so the harvest of coho must be done in a relatively short period of time. The narrow harvest window coincides with the commercial fishery and leaves the farmer with little choice about harvesting even if sale prices are low. The farmer raising accelerated coho is, therefore, forced to accept whatever price the market offers during this time of abundant supply.

The narrow marketing window for accelerated coho is one of the main reasons for the growing interest in rearing chinook. The chinook's longer production window offers the farmer more marketing alternatives during the longer growing period.

The model, while simplifying the analysis of scenarios where the factors are used, does not allow a variety of others to be modelled as easily. For example, a farmer may choose to begin the chinook harvest in February, but sell the majority of the fish late in the season when the average weights are higher. To model such scenarios, the calculations in the "number sold" column must be replaced with those describing the desired pattern of fish sales.

18. Average weight of harvested fish

Column 18 reports the average weight of the fish that are harvested, as a result of the chosen hurdle weight and speed of harvest.

The average weight reported is the estimated weight in the middle of a given month, and is based on the beginning and end weights listed in column 5a.

19. Total round harvest

Column 19 reports the total weight of fish in-the-round harvested in a given month. The total harvest for a given month is the product of the number of fish sold (column 17) and the average weight during the month (column 18).

The total appearing at the bottom of column 19 is the cumulative harvest for the entire production cycle, for a given stock. For each individual stock, after the start-up phase, the total of the column will be produced each year. The annual harvest for the chinook is therefore 291 tonnes, as of the third year of operations. The annual harvest for the coho is 150 tonnes, as of year two. The total annual production of fish in-the-round is therefore 441 tonnes.

20a. Actual percentage of down-grades

Farmed fish are meant to be sold as top quality fresh fish for the white table cloth market, or equivalent. People talking about farmed salmon prices are invariably referring to the top-grade. While all farmers attempt to produce nothing but top-grade fish, there is always a certain percentage of "down-grades". These down-grades represent a hidden cost to farmers, and can seriously reduce revenue from a harvested crop.

Column 20a indicates the percentage of the number of fish harvested that are expected to be down-graded in a given month's harvest. The percentage of down-grades is generally low, but tends to have seasonal highs due to "jacking" and the onset of sexual maturity.

A chronic level of 3% down-grades is a reasonable measure of the number of fish that will be deformed, blind, disfigured due to seal attacks, or otherwise unpresentable as first quality fish at the time of harvest.

The onset of sexual maturity in the coho, and the accompanying discolouration and softening of flesh, results in a rapid increase in the percentage of down-grades during their second Fall in the sea. The coho harvest should occur before the anticipated percentage of down-grades increases above the usual level of 3%.

20b. Percentage of down-grades used

Column 20b has been included to permit the "percentage of down-grades" (column 20A), assumed to occur each month, to be uniformly altered by the factor that appears on line 8 of the VARIABLES-1 page.

The factor for "PERCENTAGE OF DOWN-GRADES AS PERCENT OF ASSUMED" could be used to study the effects of such things as scale loss or disease disfigurement on profitability. For example, if a farmer were to consider a new grading technique that could increase scale loss on harvested fish, he could estimate the losses from down-grading due to scale loss by increasing the factor on line 8. Doubling the factor to 200% (from 1 to 2) would imply that chronic levels of down-grading increased from 3% to 6%.

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PROCESSING LOSSES AND COSTS

21. Weight reduction of processed fish

Column 21 reports the weight losses that are expected to occur during the processing procedure, as a consequence of bleeding and gutting. Weight reductions due to processing represent the change in weight from fish in-the-round to dressed, or marketable, weight.

The percentage of weight that is lost due to processing is determined by a table of factors that appear on the VARIABLES-1 page under line 11. The estimated weight losses due to processing have been divided according to three broad weight categories of fish being processed. For the purposes of the standard farm model, a constant level of 11% was used for all three weight categories.

The processing weight losses that can be expected to occur are dependent upon such things as species, size class, duration of pre-slaughter starvation, whether or not the gills are removed, and effectiveness of bleeding before gutting.

An anticipated weight loss of 11% is appropriate for farmed chinook and coho in the size ranges being harvested. This assumes that the fish were well starved before harvest, that they were bled as part of the processing procedure and that they were gutted but did not have the gills removed.

A weight reduction of 11% is at the low end of the scale. The removal of gills represents the loss of another 2.5 to 3.5% of the total weight of bled, starved fish, (and, incidentally, results in a higher labour charge for the processing). The weight reductions for trout are typically in the 17% range for starved fish, with gills left in. Fish that are not starved can show weight reductions that are 5% higher, since the stomach contents are removed when the fish are gutted.

The use of 11% as an estimate of expected weight reduction assumes that the weight losses are kept to a minimum.

22. Total dressed weight

Column 22 reports the total dressed weight of fish harvested each month. This is a product of the anticipated weight reductions due to processing (column 21) and the total round harvest weight for the same month (column 19).

The total for dressed weight harvested is used in later calculations of such things as production per smolt stocked and cost of production, F.O.B Vancouver.

23. Bleeding costs

Processing costs are divided into three categories, so that the benefits of performing some of the tasks on the farm can be evaluated. The table of "PROCESSING WEIGHT LOSSES AND COSTS PER KG OF FINISHED PRODUCT" on VARIABLES-1 page, provides three separate sets of costs that are incurred when converting fish in-the-round to dressed fish. The charges are subdivided into weight categories to reflect the changes in processing costs that are associated with different size ranges of fish.

The first of the three categories is "bleeding costs". Top quality fish should be bled by cutting a gill artery while the fish is alive. The heart pumps out much of the blood and results in a carcass without visible veins and arteries in the stomach cavity. The removal of blood apparently also helps prolong the shelf-life of fresh product.

The need to bleed the fish to achieve the top quality "premium" rating forces farmers to begin processing when the fish are alive. Fish can either be delivered live to a processing plant for bleeding there, or be bled on the farm and transported on ice to processing plants. The decision to use one or the other system depends on a number of factors, such as: the distance to the processing plant, the volume of fish to be harvested, the availability of storage facilities for blood water, and the cost of live versus iced transport. Bleeding on the farm and transport of iced fish can result in savings of as much as $0.50/kilogram, but requires pumps, bleeding tanks, totes, ice and extra personnel, making it logistically difficult and expensive for many farms.

For the model's standard farm, it is assumed that bleeding is done at the processing plant at cost of up to $0.25/kilogram. This also implies a higher cost of transporting the fish to the plant, of $0.33/kg (VARIABLES-2, line 13). It does not, however, require a large expenditure for the facilities necessary to bleed and ice the fish on the farm.

As the table of processing costs indicates, the cost of bleeding, per unit weight harvested, decreases with increasing size as a result of diminishing handling problems. The costs associated with bleeding are automatically calculated by the program, based on the charges indicated in the table and the average dressed weight of the fish harvested. The cost per kilogram for bleeding is then multiplied by the total dressed weight harvested (column 22) to arrive at a monthly total for bleeding costs.

The use of dressed weight as a basis for the charges is a reflection of the industry practice to charge a farmer based on the weight of product that ultimately leaves the processing plant, rather than on what arrived at the plant, which would require the extra step of weighing the still live fish.

24. Gutting costs

Column 24 lists the total charges for the gutting and cleaning of fish for each month. The charges are based on the rates given in the table of processing losses and costs that appears on the VARIABLES-1 page, under line 11. The charge rate is determined by the weight category that the average weight of the fish falls into, after losses due to processing.

The standard model assumes that the processed fish are left with their gills in. This is reflected in the weight losses that have been assumed and in the charges per kilogram for gutting. The removal of gills would cost as much as $0.15/kilogram extra.

In addition to actual gutting, the gutting costs include the labour associated with cleaning, grading and packaging.

25. Packaging costs

Column 25 provides monthly totals for the cost of packaging materials used in the processing procedure. The costs of packaging materials, per kilogram of processed fish, is determined by using the average weight of the fish being processed. The table of processing losses and costs, on VARIABLES-1 page, under line 12 indicates the charges that have been assumed for each of three weight categories.

The charges shown in the table for the standard farm represent the cost of packaging in styrofoam boxes capable of holding approximately 20 kilograms (40 to 50 lbs) per unit. Within the containers, the fish are well iced. While styrofoam containers are often put into cardboard boxes for air shipment, the cost of this extra step has not been included. Since some of the product is sold loose in totes for the local market and some is sold in cardboard "wet lock" boxes, this represents a typical method of packaging and a reasonable average cost for packaging materials.

26. Total processing costs

Column 26 simply provides a monthly total of all the charges associated with processing (column 23 + column 24 + column 25).

A recent study by the B.C. Salmon Farmers Association (BCSFA) on the "Harvesting, Processing and Transportation Costs in the B.C. Salmon Farming Industry" (January 1989), demonstrated that there are considerable variations in the cost of converting round fish on the farm to dressed fish in Vancouver, between various regions of the province. The lowest total cost, estimated for the farmers in the Sechelt area, was $1.30 per kilogram. The Campbell River area had an estimated cost of $1.55/kilogram. The North Island region had the highest estimate of the regions studied, at $1.80/kilogram.

To compare the costs that have been assumed for the standard model with the results of the BCSFA study, it is necessary to add transport costs to the processing charges totalled in column 26. The transport charges for moving live fish from the farm to processing, and for getting packaged fish to Vancouver, are determined by factors that appear at the top of VARIABLES-2 page, under line 13.

Summary statistics for processing costs appear under the heading of "F. PROCESSING" on the left-hand side of VARIABLES-1 page. The summary statistics provide a total for processing costs, without transport charges included, per kilogram of dressed fish produced for each of the two species. To convert to the format used in the BCSFA report, it is necessary to add the transport costs, per kilogram of dressed product, that appear on VARIABLES-1. Total processing costs, including transport, for the chinook are $1.36/kg ($0.33 +$0.12 +$0.91), and for the coho, $1.49/kg. For the two species combined the total processing cost is $1.40/kg. The standard farm model, therefore, has cost assumptions comparable to the Campbell River area.

Differences in processing costs between the two species in the standard farm model are a consequence of the different average weights of fish being processed. Processing costs decrease with increasing average weight of the fish being handled, since the larger fish are easier to handle and fewer pieces make up more weight. As a result, the processing cost per kilogram of product decreases as the average size of the fish harvested increases. The coho were harvested at a smaller average size than the chinook, and were therefore more costly to process.

In its study, the BCSFA only considered fish in the 4 to 6 lbs (2 to 3 kilograms) size category. Processing costs for smaller fish would be higher than the averages reported. Consequently, the study provides a low estimate of the overall cost of processing because a typical population of fish would show a wider range of weights.

The program allows the user to analyze a great variety of changes in processing costs. The factors in the table of processing costs and losses and transport costs are all subject to change.

REVENUES AND INVENTORY VALUE

27. Top-grade price

Column 27 reports the price received for the top-grade segment of the harvest in any given month. The price received is determined by a combination of three factors on VARIABLES-1 page, and by the average weight of the fish in that month, as discussed below.

The table under line 12, on VARIABLES-1, called "SALE PRICES FOR TOP GRADE (F.O.B. VANCOUVER, CLEANED AND PACKAGED)", provides lists of prices according to species and size category. The first half of the table (ACTUAL PRICES) is a set of sale prices that may be changed by the analyst. The second half of the table (PRICES USED) are protected from editing and are the prices that are used by the model to generate revenue estimates. The "prices used" are derived from the "actual prices" by a factor that appears on line 9 of the same variables page, and which can also be altered by the analyst.

The structure of the model allows the user to vary the sale prices by weight category and species, as well as to invoke uniform price changes by using the price factor on line 9. It also allows prices to be altered for sales that occur during the commercial fishing season, as is discussed below.

The top grade price for a given month is established by the average weight of the fish for that month. The weight category that the average weight of the fish stock falls in determines the price received.

The prices used for the standard farm are reasonable estimates of what was being received in March of 1989. The prices are lower than what was received during the same period last year because of the rapid growth of the worldwide supply of farmed salmon and the U.S. exchange rate.

To allow for price softening during the commercial fishing season, a factor has been included that adjusts the top grade price during the third quarter of each year (July, August and September). On the VARIABLES-1 page, at the bottom of the table of fish prices (under line 12) is a factor labelled "PRICE REDUCTION FOR SALES THAT OCCUR DURING THE COMMERCIAL FISHING SEASON:" which reduces the PRICES USED for all third quarter sales. (N.B. The use of the term "price reduction" for this factor may be misleading. It is, in fact, the percent of the "actual prices", and not the percent by which the "actual prices"are reduced.)

For the standard farm, the reduction in price between winter and late summer sales is assumed to be 10%. This reduction is achieved by setting the price reduction factor at 90%. The same price reduction occurs for both species.

The summer price reduction factor allows the analyst to test for the effects of large commercial fishery harvests on the viability of farming species that require late summer harvests.

In general, the summer "softening" of salmon prices has been less than anticipated. A reduction of 10% adequately reflects what occurred in 1987 and 1988. A large number of farms are raising fish that will generate late summer sales. The decision to do so is based largely on relatively high prices that have been received during the late summer, and on the larger average weights that can be achieved by this time.

28. Revenue from top-grade sales

The revenue from top-grade sales is calculated by multiplying the total dressed harvest weight for a month (column 22), after reduction due to down-grades, by the top-grade price received for the average weight of fish sold during the month.

29. Down-grade price

The sale price of down-graded fish is determined as a percentage of the top-grade price. Line 10 on the VARIABLES-1 page determines the percentage of the top-grade price that is received for the down-graded fish. For the standard farm, both the coho and chinook down-graded fish receive only one half of the top-grade price.

In practice there are two levels of down-grading, "standard" and "utility". In a normal, healthy population, the percentage of fish that are down-graded is between 2 and 4% and these are principally dropped down only one step, to standard grade. Standard grade fish typically receive about 60% of the top-grade price. Utility grade, which is usually smoked or further processed, receives only about 30% of the top-grade price. An average of 50%, used for the standard farm, implies that the majority of the down-graded fish became standard grade.

30. Revenue from down-grades

Column 30 is the product of the price received for down-graded fish (column 29) times the weight of down-graded fish, (column 20b times column 22).

31. Market value of inventory

Column 31 is a running total of the market value of inventory in the nets, at the end of a given month. It is calculated as the top-grade price, reported in column 27, times the total biomass of fish remaining at the end of a month (column 7). The market value of inventory is used in the calculation of stock insurance charges, which are dependent on the peak value of the two stocks of fish being insured.

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PEN REQUIREMENTS AND COSTS

32. 1st year pens

To simplify the modelling of changes in the scale of the farm, the program has been designed to purchase pens and nets automatically, according to the requirements and costs set out on the VARIABLES pages.

Factors for "loading density", "net depth" and "pen dimensions", on VARIABLES-2 page, are used to determine the carrying capacity of a given net pen (21600 kilograms). Dividing the biomass of fish of each stock that must be housed, by the capacity of each net pen, determines the number of net pens required.

The program automatically purchases two net pens whenever the target density of fish for the farms is exceeded. The cost of each pen is based on a "cost of walkways" factor for each linear meter of walkway. The first two pens purchased for each stock are each assumed to have four sides of equal length (15 meters on the standard farm). All later pens are assumed to have only three sides because they are added onto the existing pens. This assumption, of three sides per additional pen, is based on the reasonable assumption that the main walkway, that would be shared by two pens, cost twice as much as an outside walkway would cost.

It is assumed that a farmer would purchase only two pens at a time. Typically, pens are ordered in sets of 4 to 8, to minimize construction and delivery costs. The simplification used in the program does not seriously affect the results.

Automatically purchasing two pens whenever the target density is exceeded means that there is a slight excess of space over the theoretical ideal. However, not all pens are continuously loaded to their ideal level. This slight extra space is typically vacant as the pens are somewhat unevenly loaded.

Column 32 provides a running total of the number of pens that are required to house the first year class of smolts stocked. For the chinook, the peak requirement is ten pens. The number decreases from the maximum number required as fish are harvested.

33. 2nd year class pens

Column 33 provides a running total of the number of pens required to house the second year class of smolts of a given variety.

It is important to appreciate that column 33 is the first column in the production statement which refers to the requirements of a subsequent year class. The fact that a stock of fish is held on a farm for more than one year means that there will be overlapping requirements for net pen space. Column 33 reports the requirements for the smolts that are stocked in the farm's second year of operation.

34. 3rd year class pens

Column 34 provides a running total of the number of pens that are required to house the third year class of smolts of a given stock. Like column 33, column 34 refers to the requirements of fish other than those stocked on the farm in the first year of operation.

35. Number of pens required

Column 35 provides a running total of the number of pens required to house all year classes of a given variety of fish. With new smolts being stocked each year, there will be a requirement for pens to house old and new fish. The peak requirement for the chinook stock occurs in January of year 3 when a minimum of 12.4 pens are required for two overlapping chinook year classes. An additional 6.6 pens are required to house the coho by August of year two.

36. Number of pens in use

Column 36 provides a running total of the number of pens that have been purchased or that remain in use by any of the three year classes of a given stock.

The numbers in column 36 appear in intervals of two because pens are assumed to be purchased in sets of two. Increases (up to the maximum number reached) in the number reported in column 36 are the trigger for the purchases of pens that are reported in column 38.

37. Minimum biomass density

Column 37 reports an estimate of the minimum average biomass loading density of fish of all year classes, for a given stock, that are being held in the nets.

The numbers are minimum estimates because the program assumes that every cubic meter of net volume that is available, is in use. This is an unrealistic assumption considering that a farmer is unlikely to keep fish as spread out as is ideally possible. Fish are typically harvested by net pen, and not evenly from all nets, and there are never only two large stocks of fish on the farm. The biomass density provided is therefore an estimate (at the end of a given period) of the least crowded the fish might be.

38. Pen purchases

Column 38 reports the monthly purchases of pens for each stock. As explained, the purchases are always in groups of two. The prices, per pen, are based on the cost per meter and pen dimensions as set-out on VARIABLES-2 page.

The program treats each species separately in determining the number of pens required. In theory, this could result in purchasing too many pens, since the pens are not assumed to be shared between species. In practice, however, a farmer is unlikely to have the exact number of pens required at any given time. Furthermore, frequent transfer of fish between pens to optimize density is impractical and would unreasonably stress the fish. The program provides a reasonable estimate of the number of pens that a farm would have if operating under the same operating restrictions (ie. loading density, net depth and pen dimension) as those assumed for the model.

NET REQUIREMENTS AND COSTS

Several ways to describe the mesh size of a given net are in use. The convention used in this program is "the half mast" measure. Thus, the designation of 6mm nets implies that the web has squares that are 6mm on each side (1/4 inch). Using another system, the same web could be referred to as 12mm "stretch" web.

Most farmers use four different sizes of nets during the life of a stock of fish. There is some variation in how long fish are held in each net size, but in general the program follows a generous pattern of net purchases.

The number of nets purchased is theoretically higher than might actually occur because the program will, under certain conditions, purchase additional nets in the month that the fish are being sold, and because the nets are not shared between the stocks even though at certain times they may be available. This imperfection provides a more realistic estimate of net purchases since, as with the pens, it is impossible to optimally utilize the nets on hand.

39. 6mm nets

Column 39 provides a listing of the number of 6mm mesh nets that are required to accommodate the first year class of each stock. The table of "COST OF NETTING AND CONSTRUCTION", on page VARIABLES-2, line 15, illustrates the relationship that has been assumed in the decision to "change" nets. The six millimetre mesh nets will only accommodate fish from first stocking on the farm, to an average weight of 50 grams. When the average weight exceeds 50 grams, the program purchases nets of the next mesh size.

The number of nets of a given mesh size that are required is a consequence of the capacity of each net. This, in turn, is a consequence of loading density, pen dimension and net depth. The numbers reported in columns 39, 40, 41 and 42 refer to the number of nets of each size that are required for each stock when they are in nets of the mesh size indicated in the heading of each column.

40. 10mm nets

Column 40 lists the number of 10mm nets required to house fish when they weigh 50 to 200 grams.

41. 13mm nets

Column 41 lists the number of 13mm nets required to house fish when they weigh 200 to 750 grams.

42. 20mm nets

Column 42 lists the number of 20mm nets required to house fish when they average over 750 grams.

43. Net purchases

Column 42 reports the total cost of net purchases for a given fish stock, for a given month.

The number of nets that the program purchases is based on increases in the number of nets required, as indicated by increases in the numbers in columns 39 to 42.

The program has been designed to calculate the cost of a net based on the dimensions given on VARIABLES-2 page. Only by calculating net prices according to pen dimensions and depth, is it possible to permit the analyst to test scenarios involving pens and nets of different dimensions.

The purchase price for a given net is determined by mesh size. The table of "COST OF NETTING AND CONSTRUCTION" illustrates the costs that have been assumed for webbing of different sizes, and for the labour per square meter of web that goes into the construction of a net. The web prices and labour factors are based on discussions with net loft operators. The cost of nets for the standard farm are in keeping with industry expectations. The web prices and construction factors have been left as variables to permit different cost scenarios to be considered.

To determine the cost of a net, the "construction factor" is multiplied by the mesh cost per square meter to arrive at a total cost per square meter. This total is then multiplied by the surface area of a given net to arrive at a total price. The construction factor takes into account the cost of labour, twine, ropes, lead line and profit for the manufacturer. The price factors for the standard farm assume that the nets are made in a private net loft, and not by the farmer.

Because only a small volume of the fine mesh nets are required for holding smolts, it is a standard practice to use smaller "smolt nets" than "grow-out" nets. To reflect this practice, the 6mm mesh nets (smolt nets) are assumed to be only 1/2 the size of the other nets and the prices are adjusted accordingly.

STATEMENT OF SOURCES AND USES OF FUNDS

PAGES - SOURCES-1A and SOURCES-1B

The statement of SOURCES AND USES OF FUNDS is entirely generated by the program, and does not have "variables" within the statement itself. The discussion that follows is an explanation of how each row of expenses, or revenues, was derived. Numerous references are made to the "VARIABLES" pages, where "factors" occur that determine the expenses and revenues that appear in the SOURCES AND USES OF FUNDS STATEMENT.

This statement acts as the basis for later financial analysis, and is meant to act as a summary document of production cost calculations and operating cost estimates. The totals for the various costs presented are used extensively in later presentations.

The SOURCES AND USES OF FUNDS statement is divided into four ranges for navigating within the spreadsheet, and for printing on letter-sized paper. Unlike the production statements, all numbers in the financial statements are in thousands in order to condense the presentations.

YEAR AND QUARTER

The first two rows of the SOURCES AND USES OF FUNDS statement illustrate time intervals. Data have been provided on a quarterly basis for the first three years, and on an annual basis for another five years. The first three years of quarterly reporting correspond to the three years described in the production statements. Data from these statements have been summarized by quarter, and are incorporated into the financial analysis.

PRODUCTION

The first row of data lists the production of dressed fish for a given period. These data have been included as a reference, and are used later in the calculation of cost-of-production per unit of dressed fish produced.

SOURCES OF FUNDS

Under the heading "SOURCES OF FUNDS", are injections of cash from revenues and loans. The only other source of funds to the farm is assumed to be equity. The program is designed to calculate how much equity is required after considering the available debt and the timing of expenses before revenues are generated. The equity required by the farm is the last number that appears on the SOURCES AND USES OF FUNDS statement, on page SOURCES-2A.

REVENUES

Top-grade sales

The revenues generated from top-grade sales, as calculated in the production statements (column 28), have been summarized on a quarterly or annual basis, and are reported in this row.

Down-grade sales

The revenues from down-graded fish sales (column 30) are summarized quarterly or annually, and reported in this row.

LOANS

Short term loans

Under line 16 on the VARIABLES-2 page, there are tables that allow the timing and magnitude of short and long term loans, and the interest rates paid on them, to be adjusted according to the scenario desired.

The loans appear as sources of funds in the statement of SOURCES AND USES OF FUNDS. They are assumed to have been incurred at the beginning of the quarter in which they appear, for the purposes of interest calculations. The timing of the loans is meant to correspond with the peak cash requirements of the farm, and to minimize that requirement as much as possible.

The category called short term loans represents the type of debt that farmers have received from European banks in the past. Farms financed in this way have a maximum line of credit that can be drawn down after a required level of equity investment has been made. The farm pays interest only on the outstanding principal for the first two years of the loan. The principal owing is then expected to be repaid fully over the next three years.

The first two years without principal repayment are meant to allow a farm to complete the first production cycle, before beginning to repay the loan. However, with operating performance at levels below budgeted, the rapid repayment requirements in years 3, 4 and 5 have resulted in cash drains that, to many farms, have been crippling.

The standard farm depicted by this model, is assumed to have a short term line of credit of $900,000. These funds are drawn down in three equal loans during the first three-quarters of the second year of operation. The interest rate of 16% (entered on page VARIABLES-2) reflects the rate that is currently being paid on such debts.

Long term loans

Debt having a different repayment structure, than the short term debt described has also been included to permit other lending scenarios to be analyzed. The long term loans are assumed to be conventional, 10 year loans with principal and interest payments occurring after a delay of only one quarter.

For the standard farm, it has been assumed that the farmer acquires $300,000 in 10 year debt in the fourth quarter of the second year of operations. This is when the maximum financial requirement is reached, just before the first chinook harvest. The long term debt is presumed to become available on the basis of high inventory values.

The standard farm is presumed to be 50% debt financed because, at the time of the peak requirement, one half of this requirement is met by debt. In the later analysis of other operating scenarios the same principle is applied, even though the peak level of debt is only maintained for a short period.

USES OF FUNDS

In the statement of SOURCES AND USED OF FUNDS, there are four categories of expenses. These are:

COST OF GOODS SOLD,
FIXED COSTS,
CAPITAL PURCHASES and
INTEREST AND PRINCIPAL CHARGES.

These four categories of "USES OF FUNDS" are employed in later financial analysis, to arrive at the total cost of production and return on investment.

COST OF GOODS SOLD

Under this heading are all those expenses that are considered to be direct inputs in the "manufacture" of fish for sale. These are expenses that occur on the farm, rather than at the administration level.

Smolts

As with the other inputs into the SOURCES AND USES OF FUNDS statement, the cost of smolts is varied by changing the factors on the VARIABLES pages. Under line 17, on VARIABLES-2, the cost of smolts can be altered from the rates chosen for the standard farm.

The cost of smolts for the standard farm has been set at $0.70 and $0.60 for chinook and coho, respectively. These prices are low by the standards of 1987 and 1988, but are realistic for the next few years since there has been a rapid increase in the number of smolts available from domestic broodstock.

The total annual cost of smolts is reported in a single quarter, on the SOURCES AND USES OF FUNDS statement. The total charge is the product of the price per smolt and number stocked, for each of the species.

Feed

The cost of feed is derived from the calculation made in the production statements. The total costs for a given quarter include the requirements of each of the two species, and of overlapping production cycles.

Medicine and veterinary services

A per tonne charge is calculated for medicine and veterinary services to allow the cost to vary with the amount of fish being raised during each month within a quarter.

To avoid manually inserting expenses for medicine, fuel, etcetera for every production scenario analyzed, it is necessary to relate these expenses to the activity level on the farm. One suitable indicator of activity is the biomass being reared. If scenarios of different scales are considered, then the biomass being reared changes, and, consequently, the cost for medicine, veterinary services, or fuel also changes. If the change in scale is not in proportion to the change in the cost of the services, then the factors on VARIABLES-2 allow the charges to be altered.

The factor for MEDICINE AND VETERINARY, under line 17 on VARIABLES-2, allows the analyst to alter the relationship between the biomass of fish being reared and the charge for medicine and veterinary services.

The charge of $10 per tonne of biomass results in a level of total costs similar to those for actual farms of a similar size and structure to the standard farm.

Feed transport

The cost of transporting feed to the farm was excluded from the charges assumed in the production statements. The separation between purchase price and delivery charges allows the effects of isolation to be effectively analyzed.

Under line 13 on VARIABLES-2 page, are factors for transport costs. The first is for the cost of transporting feed to the farm. The factor is multiplied by the quantity of feed consumed in a given quarter to determine the total cost of feed delivery.

Wages

The amount of labour required on a farm depends on the technology being employed, and the efficiency with which the labour is utilised. In order to relate labour costs to the level of activity that takes place on a farm of a given size, the program establishes the number of employees according to daily feed consumption.

The factors for WAGES, under line number 17 on the VARIABLES-2 page, provide the relationship between feed consumption per day and labour costs. The first line ($2,500 /man/month minimum plus) is a minimum monthly labour charge. It represents the wages that are paid to certain staff in excess of the average that is set by the factor for the cost per labourer per month.

The second line under the WAGES heading ($2,200 /man/month) is the average charge for labourers who work at the farm site.

The third line (.75 tonnes/day/man) is the relationship between the quantity of feed consumed by all the fish stocks in a given day, and the number of men or women that are required to do the feeding and other work that is required at a farm operating at that activity level.

To determine the number of labourers required, the feed consumed in a given quarter is divided by 90 days. This number is then divided by the factor for "tonnes/day/man". The result is an average number of labourers required for that quarter.

The total quarterly labour bill is the total of the minimum charge per month, plus the number of labourers required, times the monthly cost per labourer, times three months per quarter.

The program assumes that part time employees are available and that fractions of monthly wages may be paid.

The factor of .75 tonnes of feed per man per day would sound low to most farmers. Labourers are able to deliver as much as 2 tonnes per man per day. A factor of .75 reflects the fact that feeding is only one of the tasks on a farm. For the standard farm, the factor of .75 results in a total wage bill of $118,000 per year and assumes that two to three labourers are required on the farm.

An average cost of $2,200 per labourer reflects the cost of wages and overhead for good staff members, on farms in remote locations.

Fuels

The relationship between the cost of fuels and the level of activity on the farm is the same as that for medicine and veterinary services. The cost for fuels increases with the biomass being farmed, and therefore the charge is related to the biomass remaining at the end of a given month.

The level of $5 per tonne reflects the costs for fuel for a single independent farm that operates a diesel generator for electricity, but does not use automatic feeders.

Fish transports x 2

In the row labelled "fish transports x2", the charges for transporting fish to the farm, and of transporting processed fish to Vancouver have been combined.

As has been described, the charges for fish transports are set by the factors that appear on the VARIABLES-2 page, under line 13.

The combined cost for both types of fish transports is the sum of the products of each of the two transport factors, and the dressed weight of fish produced in each quarter.

Processing and packaging

The costs of processing and packaging are taken directly from the calculations made in the production statements.

Transport premium

A factor for a "transport premium" has been included so that sensitivity analysis can be performed on the effects of distance on the cost of production.

The transport premium at the bottom of the COST OF GOODS SOLD category affects only the costs of: smolts, medicine and veterinary services, wages and fuels. Other costs in the "COST OF GOODS SOLD" category have transport charges that may be altered elsewhere.

The level of the transport premium is determined by a factor on VARIABLES-2 page. The variable is a percentage that will create an expense which is a fraction of the nominal charges for smolts, medicine, wages and fuels.

The transport premium factor is meant to be used when modelling the effects of distance on cost of production. With it, the operator is able to simulate the increased cost of wages, smolts and medicine for a remote farm.

The prices and charges that have been reported for the standard farm include the cost of transport. The transport premium factor is therefore set at zero.

FIXED COSTS

"FIXED COSTS" include expenses that occur at "head office", as part of the management of the farm. These charges are not fixed absolutely, but have been programmed to permit them to vary with the volume of activity on the farm.

Management salaries

Typical salmon farms have a management staff whose activities are mostly separated from the day to day farm operations. The program has been structured to reflect this separation of tasks.

For the standard farm it has been assumed that one or more managers oversee all operations at a cost of $6,000 per month.

Under line 18, on VARIABLES-2 page, are the factors that determine the management salaries paid. The first factor "$6,000 /month minimum or" determines the base rate for management salaries. The second factor "$1,000 /month/50,000 smolts" has been included to permit the charges for management salaries to increase or decrease with the size of the farm.

On the standard farm, there are 250,000 smolts stocked so the minimum rate for management exceeds the rate based on the number of smolts.

Stock insurance

Stock insurance is available to all farms, provided they meet the requirements that are imposed by the insurers. This insurance is similar to that offered to other agricultural operations, in that it allows profits as well as the cost of inputs to be insured.

Stock insurance covers catastrophic losses from disease, plankton blooms, storm damage, etcetera. The charges for this insurance vary from 3% to 6% of the peak value of insured product during a policy year. The rate varies based on the experience of the farmer, the size of the policy (economies of scale) and whether the farm is treated as a single item for the purposes of calculating deductions or each stock on the farm is treated separately.

The existence of a "deductible" before a claim may be made prevents this insurance from compensating farms for chronic losses due to BKD or Vibrio.

The stock insurance charges for the standard farm have been set at 4.5%. This rate reflects the cost of insurance for a policy with a 20% deductible, in which each of the fish stocks is treated separately, and where there is good management, high quality steel pens, and no previous stock insurance claims.

In the program, stock insurance charges are calculated on a quarterly basis rather than on an annual basis. The charges for a given quarter are derived from the combined peak market value of the two species being farmed. The combined peak market value is multiplied by one quarter of the insurance rate factor on VARIABLES-3 to determine the quarterly charge.

Asset insurance

Generally, farms have liability and asset insurance for such things as fire and theft. Within the program, the charges for this insurance have been related to the depreciated value of capital assets purchased.

In order to calculate the charges for asset insurance, the factor under line 18 of the VARIABLES-3 page (1.5% for the standard farm) is multiplied by the undepreciated balance of all capital purchases to date (available as part of the derivations within the statement of CAPITAL COST ALLOWANCE CALCULATIONS).

The cost of asset insurance is therefore related to the "market value" of assets, rather than to the "replacement value". A higher factor can be used to simulate the costs of replacement value insurance.

Office and telephone

As with the charges for fuel and medicine, office and telephone costs have been tied to the total biomass on the farm. The logic behind this relationship is that the activity of the farm's management and office staff will be dependent upon the level of activity on the farm, which is directly related to how much fish is being raised at a given time.

Ten dollars per tonne, for the standard farm, (factor on page VARIABLES-S0) reflects the cost of an office service and shared secretary. Farms which operate from the manager's home, or have an independent office would have lower and higher factor rates, respectively.

Legal and accounting

This heading includes the legal and accounting costs associated with the start-up of the farm, and the on-going charges for these services.

Charges for start-up include: structuring shareholder agreements, incorporation and set-up of an accounting system. The start-up charge of $30,000 for the standard farm is a generous estimate of legal and accounting expenses expected at start-up.

The ongoing charge for legal and accounting services is related to the biomass of fish being managed during a given quarter. Under line 18 of VARIABLES-3 page, the floating charge for legal and accounting services has been set at $2 per tonne managed per month, for the standard farm. This rate results in an annual charge of $5,000.

Maintenance

To allow for the upkeep of assets as they wear out, an allowance has been made for a maintenance expense. This expense covers labour and materials used to extend the useful life of assets, mechanical repairs, major net repairs and boat maintenance. This category of charges represents the portion of maintenance costs that are not "capitalized".

The maintenance expense in the model begins after the first year of operations, when assets have begun to deteriorate. The expense is related to the value of capital assets that are over one year old. The factor for the maintenance expense (on page VARIABLES-3) is set at 5% for the standard farm. This represents an annual charge of $54,000 per year after full production is reached. This level of maintenance reasonably reflects the costs associated with an operating farm having a wide variety of assets.

Miscellaneous

The last expense under the heading of "FIXED COSTS" is the miscellaneous category of expenses. It includes overhead costs that have not been included in previous categories such as: travel, vehicle insurance, paper products for the living quarters, cleaning materials, dog food, paints etc.

The miscellaneous expenses are calculated as a percentage of all previous "fixed costs" during a given period of time. The level of this charge is determined by the "MISCELLANEOUS" factor that appears on VARIABLES-3 under line 18.

The miscellaneous factor for the standard farm has been set at 20%. This represents a liberal estimate for this category of expenses, allowing an annual charge of $50,000.

PAGES - SOURCES-2A and SOURCES-2B

CAPITAL PURCHASES

Under the heading of "CAPITAL PURCHASES" are all purchases that cannot be "expensed" but must be capitalized for the purposes of calculating a capital cost allowance then used in the determination of taxable profits.

Pens

The charges for pens, and the timing of purchases, have been taken from the production statements (column 38) and have been totalled for the three months of each quarter, and for the two species.

Nets

The charges for nets, and the timing of purchases, have been taken from the production statements (column 43) and totalled for the three months of each quarter, and for the two species.

Anchoring

The charges for anchoring a farm are directly related to the number of pens and barges that are anchored, and to the anchoring systems used.

The program allows for a start-up anchoring charge as well as for a charge per pen anchored. The start-up charge represents the cost of anchoring the barge and one half of the first pen purchased. The anchoring charge per pen represents the cost of anchoring each additional pen.

The anchoring charges for the standard farm have been set at $5,000 at start-up and $1,500 per pen. These charges represent the costs associated with top quality anchoring materials, which include; 1.25" polypropylene rope, chains, shackles, floats and five tonne concrete blocks.

Feed storage

The costs for feed storage are based on an estimate of the storage capacity required by the farm. It is assumed that the standard farm will require storage for a two week supply of feed. The storage facility requirement is filled by a single purchase in the third quarter of the first year of operations.

The calculation for a two week supply of feed assumes that the maximum monthly feed requirement, for either fish stock, adequately represents the total needs of both stocks for any two week period. The two week feed requirement is then multiplied by the cost factor for feed storage to arrive at the total purchase price for the feed storage facility.

For the standard farm, the factor for feed storage is $2,000/tonne of requirement. This charge amounts to a total of $106,000 and reflects the cost of a large concrete barge, which is shared with the accommodations facilities.

Accommodations

In the standard farm, it is assumed that the accommodations are built on the same barge as is used for feed storage. This arrangement is a common feature on fish farms.

The assumption that the barge is shared between accommodations and feed storage requires that the purchase price of the barge be divided between the two uses. A factor of $17,000 for accommodations per labourer represents the cost of construction of accommodations and working facilities on a concrete barge that also serves as a feed storage facility. The cost of accommodations includes construction and furnishings.

The total charge for accommodations is derived from the number of employees required (as previously calculated) times the factor per labourer required. The one-time purchase is assumed to occur in the second quarter of the first year of operations.

Between the feed storage and accommodations purchases, the standard farm has an expense of $182,000. This is lower than the prices paid for such facilities by some farms, but is realistic.

Decks and docks

The purchases of decks and docks has been related to the total purchases of feed storage facilities. This relationship is based on the assumption that the requirement for additional working space will be related to the requirement for feed storage space.

Included under the heading of "decks and docks" are purchases of extra walkways, temporary sheds, net cleaning facilities and related working and storage space.

The factor for the purchases of decks and docks is set, for the standard farm, at 30% of feed storage costs. This represents one-time purchases of $32,000.

Power supply

The cost of the power supply is based on a one-time purchase of a generator, fuel tanks and controller units. The magnitude of this expense is determined by the farm's requirements. The standard farm, with accommodations on a barge, is assumed to depend on a generator for electricity and therefore requires a 20 kilowatt generator, costing approximately $15,000, including installation.

This level of expense would not be enough to purchase a generator with sufficient power to drive a large, computerized feeding system, and would be too high for a small farm with only caretaker facilities.

Feeders

It is assumed, for the standard farm, that all feed is delivered by hand and feeders are not employed.

If scenarios that include feeders are to be considered, the analyst should be aware that there are two basic types of feeders available. The relatively uncommon centralized feeders operate on computer-driven programs and deliver feed from silos to as many as 30 pens at a time. These feeding systems are very expensive, costing up to $130,000 including installation and piping.

The second basic type are the individual hopper feeders which have timers controlling the duration and frequency of feedings. They are filled by hand and float in the water or sit on a walkway. One is required for each pen at a cost of approximately $1,000 each.

There are a variety of other feeder systems with some characteristics of each of the two described and with intermediate costs.

The program has been designed to permit either, or both, varieties of feeding systems to be employed. On VARIABLES-3, under line 19, there are two factors for "FEEDERS". The first category, "$0 after one year", allows for a one-time purchase of a centralized feeding system. The second category, "$0 /pen", will automatically purchase feeders, at the factor rate chosen, for each pen that is purchased.

If feeders are assumed to be used, then the factor for the "number of tonnes/man/day" that is used to calculate the labour bill, must also be changed. Examples of these types of changes are illustrated in a later section of this report.

Centralized feeders do more of the work on the farm than hopper feeders since they transport the feed to the pens as well as deliver it. There is, however, some debate about which feeders are most cost effective in terms of labour saving and feeding efficiency.

Boats and trucks

The program allows for a one-time expense for boats and trucks, as well as an ongoing charge. The major expenses for boats and trucks generally occur at the beginning of operations. However, there is also an ongoing requirement for outboard motors, small boats, oars, motor parts and other related purchases.

To allow for start-up purchases as well as on-going purchases, factors have been created for each.

For the standard farm, the start-up purchases have been set at $40,000, and the on-going charge at $1.00 per tonne of biomass managed each month. The start-up charge allows for the purchase of a truck and aluminum crew workboat. The on-going charge allows for the purchase of small boats, small engines and related accessories.

Miscellaneous and farm equipment

In addition to those capital purchases already described, there are always start-up costs that must be capitalized, as well as a great variety of miscellaneous equipment required.

The start-up expenses that must be capitalized include: shareholders' time and money to plan, organize and initiate the project, the acquisition of a fishfarm lease, etcetera. These expenses are "capitalized" instead of "expensed" due to Revenue Canada requirements.

Miscellaneous equipment required includes: diving gear, water pumps, rope, hand tools, dip nets, and rain gear. Larger purchases include net washers, net rollers, pressure washers, fish graders, fish pumps and sorting tables.

The level of technology employed on a farm will determine the level of miscellaneous purchases that are made. A farm with first class accommodations tends to have first class diving gear and sorting equipment. The on-going purchase of miscellaneous equipment is therefore related to the total of previous capital purchases.

The factors for capital purchases appear on VARIABLES-3, under line 19. The start-up charge for the standard farm is $100,000 and reflects the practice of purchasing farm sites and of including all shareholder, start-up costs in the expenses of the farm.

The factor for miscellaneous equipment purchases is 15% of previous capital purchases. This rate amounts to $227,000 in purchases in the first three years of operations. This level is high for a moderate sized farm, but is not unreasonable considering that a net washer can cost $35,000 and requires a net roller which costs an additional $8,000.

Transport premium

Like the transport premium for elements of the "COST OF GOODS SOLD" already discussed, the transport premium for capital goods has been included to permit the effects of distance and transport costs to be studied.

The transport premium adds an expense that is a percentage of all previous capital purchases. The basis for this charge is that any increase in distance from an industrial centre will result in an increase in the cost of capital goods, as a result of transport costs. This increase would be a relatively small proportion of the cost of a barge, but could represent a significant price increase on the cost of diving equipment.

The transport premium factor is meant to be used as an average price increase for transport costs that are associated with increasing distance from centres, or other factors.

For the standard farm, it has been assumed that the capital purchases have included the cost of transport, and therefore the factor for the transport premium is set at zero.

Replacements

The line for replacement purchases is included to allow for the replacement of assets as they wear out. The inclusion of replacement purchases is a fundamental requirement of the model, since it is assumed that the assets used in the production process are 100% effective throughout the forecast period. Without replacement purchases, the only upkeep of assets used in the production process would be due to maintenance, which is inadequate considering the short useful life of such things as nets and workboats.

Starting in the third year, the program automatically replaces a percentage of the capital items that were purchased at least three years previously (but not including replacement purchases). The percentage that is replaced is determined by the factor that appears under line 19 on the VARIABLES-3 page. For the standard farm, this percentage is set at 10% and represents $96,000 in replacement purchases by year 5.

INTEREST CHARGES AND PRINCIPAL REPAYMENTS

Payments for the servicing of long and short term debt are derived from calculations made in the statement of DEBT SERVICING CALCULATIONS, and are a consequence of the timing and magnitude of loans and the related interest rates factors that appear on the VARIABLES-2 page.

The values for interest charges and principal repayments that appear on the statement of SOURCES AND USES OF FUNDS have simply been transferred from the statement of DEBT SERVICING CALCULATIONS.

TAXES

In the program, the income tax rate has been assumed to be a constant 46% of income after allowable expenses. In the calculation of taxable income, losses have been carried forward. The fiscal year is assumed to correspond with the calendar year.

The factor to set the tax rate appears on page VARIABLES-3

REQUIREMENT FOR PERIOD

The REQUIREMENT FOR PERIOD row provides a total of all SOURCES OF FUNDS less all categories of USES OF FUNDS for any given period. Positive values represent equity requirements. Negative values imply that revenues and bank loans were sufficient to cover the cash outflows for the period being considered.

ACCUMULATED REQUIREMENT

The ACCUMULATED REQUIREMENT row provides a running total of the requirements of the farm up to the date being considered. Positive values for the ACCUMULATED REQUIREMENT represent the level of equity funds that are required at any given time to meet the financial needs of the farm. A negative value implies that no equity is required, and that there is a cash surplus.

EQUITY REQUIRED

The EQUITY REQUIRED row has only one number. This number is the equity investment required by the farm. It is the maximum of the ACCUMULATED REQUIREMENT row, and is used in later calculations of return on invested equity.

STATEMENT OF DEBT SERVICING CALCULATIONS

PAGES - DEBT-A and DEBT-B

To generate the statement of SOURCES AND USES OF FUNDS, it was necessary to calculate interest charges and principal repayments for the loans assumed to have been available. These calculations are presented in the STATEMENT OF DEBT SERVICING CALCULATIONS.

As previously described, the available debt is of two types. What is referred to as short term debt is actually treated as a line of credit that is available for two years, with interest paid only on the outstanding principal. The total debt is then repaid in the last three years of the loan.

The second type of debt is referred to as long term loans. These loans are conventional 10 year bank loans with interest and principal payments beginning at the end of the same quarter in which funds are received.

The calculation of debt servicing charges are self explanatory. The timing of the loans and the interest rates charged are determined by factors on VARIABLES-2 page. Interest is charged on the principal remaining at the beginning of a quarter.

STATEMENT OF CAPITAL COST ALLOWANCE CALCULATIONS

PAGES - CAPITAL-A and CAPITAL-B

To generate an income statement, it is necessary to have a depreciation expense or Capital Cost Allowance (C.C.A.) for tax purposes.

In reality, the assets purchased by a fishfarm would fall into a number of different "classes" for the purposes of calculating the C.C.A. In the program, all assets have been lumped into a single category. The C.C.A. expense is deducted from the common pool of assets on a declining balance basis.

The C.C.A. rate used is determined by a factor on line 20, on page VARIABLES-3. In keeping with taxation standards, only one half of the annual rate is deducted in the year that an asset is purchased.

An overall average C.C.A. rate of 20% is considered to adequately reflect the allowable deductions for tax purposes. For the standard farm, a rate of 25% has been assumed because this rate better reflects real depreciation, and therefore provides a more realistic measure of the total cost of production for the farm.

INCOME STATEMENT

PAGES - INCOME-A and INCOME-B

The income statement is essentially a summary of the financial calculations made in the statements already described.

GROSS PROFIT is derived from total REVENUES less the total COST OF GOODS SOLD, as were calculated on the SOURCES AND USES OF FUNDS STATEMENT.

NET PROFIT is derived by subtracting total FIXED COSTS, INTEREST CHARGES and CAPITAL COST ALLOWANCE deductions from GROSS PROFIT.

NET PROFIT is reduced by TAXES, (after carrying losses forward), to derive PROFIT AFTER TAX.

INTERNAL RATE OF RETURN AND NET PRESENT VALUE CALCULATIONS

The internal rate of return (I.R.R.) and net present value (N.P.V.) of after tax cash flows for ten years are used for measuring return on invested equity. The amount of equity invested is assumed to be the maximum of the ACCUMULATED REQUIREMENT row on the SOURCES AND USES OF FUNDS statement.

The I.R.R. and N.P.V. calculations take place in the "range" within the spreadsheet called "IRR". This area will not need to be referred to unless the analyst wishes to change the discount rate (currently set at 10%) for the N.P.V. calculation or an error message (ERR) appears for the I.R.R. rather than a number in percentage form. If this occurs, then the "guess" within the I.R.R. formula is not close enough to the actual, and must be changed. The use of the range name IRR with the Go To key (F5) will find the correct place within the model to change the guess or the discount rate.

The results of the I.R.R. and N.P.V. calculations appear on page VARIABLES-2, as part of the summary statistics, and on page SUMMARY.

For the standard farm, the I.R.R. calculation reports that the return on invested equity, based on after tax cash flows for a ten year period, is 18.8% and the net present value using a 10% discount rate is $475,000. Considering the risks to invested equity that are associated with a new industry like fish farming, this rate of return is low. When one considers that the standard farm, presented here, is presumed to be well run and reasonably lucky in terms of mortalities and growth rates, the result bodes ill for many other farms.

STATEMENT OF SUMMARY STATISTICS

The statement of summary statistics provides a few of the main statistics for the farm which is being modelled. These same statistics, as well as a number of others, are also provided on the VARIABLES pages. The statistics chosen for the summary statement have been included because they provide an excellent snapshot of the production and financial results for a given analysis.

SUMMARY STATISTICS

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DESCRIPTION OF FARM BEING MODELLED:
- -50% debt
- -Moderate sized farm, 10 km from road and 50 km from processing.
- -Uses metal pens, no feeders, accommodations and feed storage on barge.
- -Fish are taken away alive for processing.

PRODUCTION

	No. smolts started	TOTAL HARVEST		AVERAGE WEIGHT		PRODUC./SMOLT			FEED CONVERSION (Feed/flesh)		AVE. SALE PRICE		
		Round weight	Dressed weight	Round weight	Dressed weight	Round weight	Dressed weight	MORT.	Round	Dressed	F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	150000	291408	259353	2.81	2.50	1.94	1.73	31%	2.10	2.36	$8.45	$6.39	$2,191,257
COHO	100000	150100	133589	2.10	1.87	1.50	1.34	26%	1.94	2.17	$6.57	$4.57	$ 877,193
COMBIN.	250000	441508	392942	2.52	2.24	1.77	1.57	30%	2.05	2.30	$7.81	$5.77	$3,068,449

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc.				OVERHEAD/kg of production				R.O.I.		PEAK REQUIREMENT (in millions $)	
		Feed	Process.	Trans.	Total	Fixed	Interest	Dep.	Total			Debt	Equity
$/KG	$6.69	$2.83	$0.95	$0.58	$5.18	$0.77	$0.29	$0.45	$1.50	IRR	18.78%	1.19	1.27
$/KG		42.3%	14.3%	8.5%	77.5%	11.5%	4.3%	6.7%	22.5%	NPV	$475,000		

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Printouts of the SUMMARY STATISTICS statement are all that is provided of analyses other than for the standard farm.

DISCUSSION OF THE LIMITATIONS OF THE MODEL

Two basic limitations affect the model's ability to accurately estimate the cost of production for a farm. These are:

1. Simplified cost inputs that are inaccurate when major changes to other inputs are made.

2. The necessity to base all calculations on a single average fish weight, rather than on a distribution of average fish weights.

These limitations can seriously affect the results generated by the model, and must be considered carefully when using the program to model scenarios other than those presented in this report.

1. Simplified cost inputs

The sources of error under this heading result from using factors to determine the costs in the financial and production statements rather than using actual costs or specific estimates of actual costs.

To be more accurate, precise cost expectations, particularly for capital purchases, could be entered directly into the SOURCES AND USES OF FUNDS statement in the period for which they were required. Previous versions of this program were structured on this basis, but were less "user friendly" because it was necessary for the user to have a thorough understanding of all inputs. This model greatly simplifies sensitivity analysis, but becomes less accurate as factors are used to alter variables away from known standards.

The standard farm model is considered to be reasonably robust to changes only within 50%, above or below, of the basic variable settings (line numbers 1 to 10 on VARIABLES-1 page). The precision of the forecasts made by the model decreases with increasing variation from the basic settings. When more radical alterations are required, a wide range of other settings (especially those under lines 16 to 18) must be changed to generate a "different scenario". Examples of this process are provided.

2. The use of average fish weights rather than a distribution of weights

The program bases the calculation of all production expenses and revenues on the rearing and sale of fish stocks of a single average weight. This is an unrealistic assumption that can affect the precision of the model's forecasts.

The use of a fish stock's average weight, rather than a distribution of average weights, is a useful simplification that provides accurate estimates of average feed consumption, conversion rates and net pen requirements, but less accurate estimates of processing costs and revenues.

The problems of having harvested fish in different weight classes would be eliminated if all weight categories of fish received similar prices and had similar processing costs, but this is not the case. The tables of processing costs and sale prices that appear on VARIABLES-1 page, under lines 11 and 12, illustrate the variation in sale prices and processing costs that occur with changes in processed weight. The variations in processing costs make the smaller weight categories of fish more expensive to produce than the larger. At the same time, the smaller weight categories sell for less per kilogram, than do the larger fish, and therefore have significantly different profit margins. In fact, weight categories of fish below 2 kilograms (round) are not profitable at current sale prices and processing costs.

It would be possible to eliminate the problem of sale price and processing cost differences between weight categories, by using costs and sale prices that reflect the mix of sizes in a harvested population. However, the difficulties associated with this make it impractical. A new set of prices and costs would need to be estimated for each possible average weight of fish harvested because the percentage of fish in any one size category would change continuously. In addition, there is a wide variety of possible distributions for a population, such as wide, narrow, bimodal, etc.

The use of average weights in the program generally results in processing costs being minimized and revenues exaggerated. This happens because, when a group of fish are harvested at a desirable average weight of 2.3 kilograms, the program assumes that all harvested fish end up in the same processing and sale price categories. This is a classic example of what has confronted farmers. Fish are processed at what seems to be a desirable average weight. When the results come back from the processing plant, the processing costs are considerably higher, and the revenues lower than anticipated, because a significant percentage of fish are in the small size categories.

The table below illustrates the distribution of weights that can result from the harvest of a typical population of salmon at the "desirable" average weight of 2.0 kilograms (round).

TABLE ONE: DRESSED WEIGHT DISTRIBUTION FOR STOCK WITH AVERAGE ROUND WEIGHT OF 2.0 KILOGRAMS

WT. IN KGS.	WT. IN LBS	% OF POPULATION
0 to .9	0 to 2	.5%
.9 to 1.8	2 to 4	35%
1.8 to 2.7	4 to 6	55%
2.7 to 4.1	6 to 9	9%
over 4.1	over 9	1%

The distribution illustrates that, although the average weight of a population may be within the desirable 4 to 6 pound range, as much as 1/2 may be in a smaller, unprofitable weight category.

To some extent, the error associated with the use of average weights is offset by the cancelling effect of the prices for higher and lower than average weight fish. A regular increase in processing costs and sale price with increasing size would allow a normally distributed population of fish to be reasonably modelled in this way, but costs and sale price do not increase regularly, and therefore the error remains for all populations. The typical price changes occur at 2, 4, 6 and 9 pounds for chinook and coho. Many farmers will attempt to time harvests so that the majority of the fish reach the target size category.

In order to minimize the errors associated with using a single average weight in the model, it is necessary to ensure that some portion of the harvest occurs at a low average weight (below 2 kilograms). This allows the lower profitability of the early harvest to help offset the higher profitability of later harvest.

A good example of this is the timing of the coho harvest for the standard farm. The hurdle weight to start the harvest was set at 1.9 kilograms. Thus, the harvest began in August at an average weight of 1.9 kilograms. After processing losses, the average weight for the August harvest was low enough to result in the processing charges being set at the level for 0 to 1 kilogram fish. The sale price was set at the low rate of $6.60. The September coho harvest had an average weight of 2.3 kilograms and was therefore more profitable. In combination, the two months of harvesting provide a low estimate of the profitability of a coho harvest with an average weight of approximately 2.2 kilograms. The estimate is low because over half of the number of pieces sold were assumed to be in the smaller size category.

The chinook harvest for the standard farm is quite different. For this harvest a hurdle weight of 2.1 kilograms was set and began at an average weight of 2.175 kilograms. Thus, the program determined that all chinook harvested were in the large size ranges. This assumption is realistic only if it is further assumed that the fish harvested were not of average weight but were "top-graded" to prevent the harvest of the smaller size. Since this is a common and growing practice, the assumption is realistic, but provides a high estimate of the profitability of the chinook harvest for the standard farm.

In combination, the coho and chinook harvests provide a realistic picture of the cost of production and profitability of a salmon farm having the characteristics described.

The limitations of the program that are associated with the use of a single average weight can therefore be minimized through careful consideration of how they affect the overall costs and revenues of the farm being modelled, much as a diligent farmer would carefully consider the impact of the timing of his harvest on his costs and revenues.

RESULTS FOR THE STANDARD FARM

The standard farm depicted by this model is intended to serve as a "typical" farm within the constraints imposed by the program. The operating and financial results are therefore indicative of what can be expected to occur at farms of the same size and management style in the industry.

The total tonnage produced each year, after the two year start-up phase, is 441 tonnes round weight, and 392 tonnes dressed weight. This level of production represents that which a well run farm, of moderate to large size, can expect to produce, based on the number of smolts stocked.

The total tonnage that a farm will harvest depends on the number of smolts stocked, the average weight of the fish harvested, and mortalities. The standard farm would be considered successful with an average "production per smolt stocked" of 1.77 kilograms round weight and 1.57 kilograms dressed weight. Farms with significantly higher mortalities, and/or sales that occur at lower average weights, could have values for the production per smolt stocked of between 1.1 and 1.3 kilograms dressed weight. The model would predict an average cost of production for these farms that is higher than the prediction for the standard farm.

Statistics for feed consumption include: the total weight of feed consumed, the total expense, the average purchase price (not including transport), the biological conversion efficiency (feed consumed to round weight for a population) and the economic conversion rate (feed consumed to dressed weight harvested, for a population), and the total feed cost per kilogram of fish marketed.

The economic conversion rate of feed to marketable product is the most significant result. It provides the relationship between the purchase price of feed and the portion of the total cost of production that is feed costs. An economic, or practical, conversion rate of 2.3 would be a surprising result to many observers who hear of biological conversion rates in the range of 1.3 to 1.8. When making rough estimates of the feed cost of production, it is common to use a conversion rate of 2. The results for the standard farm illustrate that a conservative estimate of feed cost would be based on a rate of 2.5 to 1.

The relatively high dressed and round conversion rates for the chinook (2.36 and 2.1, respectively) relative to the coho (1.9 and 2.13) are a consequence of differences in the timing of mortalities between the two species. On average, chinook mortalities occur later, at a larger average weight, than coho mortalities. Thus, chinook losses cost more in terms of feed consumed by the population relative to the weight of fish harvested.

The total cost of production for the standard farm was $6.69 per kilogram sold. Of this, feed represented 42.3 percent, processing 14.3 percent (not including fish transports), transports 8.5 percent (for feed and fish), fixed costs 11.5 percent, interest 4.3 percent, and depreciation 6.7 percent. Not included in the summary statistics section was the total for wages, smolts, medicine and fuels, which amount to 12.4 percent of the total cost of production, or $0.82 per kilogram of product sold.

When presenting a value for the "cost of production", it is necessary to clarify the intended meaning. The cost of production reported for the standard farm is the cost of production - F.O.B. Vancouver, before commissions paid to brokers. The definition can be made more precise by adding that it is the cost for a farm that enjoys 50 percent leverage, and has transport costs comparable to farms in the Campbell River area.

A precise definition is required because the term "cost of production" is used in the industry to refer to several different sets of costs. Earlier analyses of the cost of production performed by the author (May 1987), were restricted to the farm gate cost of fish in-the-round for the Sechelt area. The earlier estimates were in the range of $4.30 to $4.50 per kilogram for a farm of the same size, location and level of debt. This compares with farm gate, round, cost of production, generated by this model for the standard farm, of $4.76 per kilogram. The difference between the earlier and later estimates is the consequence of actual growth rates being lower than predicted in 1987.

The variation in total cost, between the earlier and current estimates of the cost of production amount to only 7 to 10 percent. Although the earlier estimates were not far wrong, they provided a misleading impression of the practical cost of production.

The cost of production in this model does not include the sales commission which ranges between 3 percent and 8 percent of the cost of sales. This is consistent with the way in which the B.C. Salmon Farmers Association reports prices. Specifically it represents all costs for the first receiver of farmed salmon, but not any mark-up they may apply.

The return on investment for the standard farm is estimated at 19 percent. Since the return on investment is very sensitive to the choice of sale prices used, the level reported can only be considered an estimate, based on relatively low fish prices, combined with good management, and moderate levels of mortality.

ANALYSES OF OPERATING SCENARIOS OTHER THAN THAT OF THE STANDARD FARM

The standard farm can be described as a well run farm, with moderate losses, medium to high expenditures for equipment and labour, and a moderate level of debt. In the text that follows, the model for the standard farm will be altered, step by step, to demonstrate how the program "factors" can be modified to simulate different operating scenarios. The description of the changes to the standard farm is meant to act as a tutorial in the use of the program.

The following discussions are meant to serve as examples of how the program is used, rather than as precise analyses of other operating scenarios.

INCREASE IN THE SCALE OF OPERATIONS

Several steps are required to simulate a farm that is larger than the standard farm. The changes that are required reflect the increased costs of some inputs, plus the lower costs arising from economies of scale.

All factors that are not specifically referred to as having been altered, are left at those settings previously described for the standard farm. The magnitude of the changes indicated are reasonable approximations based on the authors' experience.

The factors that must be changed, in the same order as they appear on the VARIABLES pages, are:

1. NUMBER OF SMOLTS STOCKED - must be increased to reflect the change in the volume of operations. For the purpose of this example, the number of smolts stocked will be doubled to 300,000 for the chinook and 200,000 for the coho. Without changes to the mortality rates, growth rates, or harvesting dates, the total production for the farm will double as a result of this increase in the number of smolts.

16. LOAN TIMING AND INTEREST CHARGES - for the purpose of comparison with the standard farm model, the level of debt for the increased scale scenario is presumed to be retained at 50 percent. It is therefore necessary to increase the loans that are assumed to be available.

The user can only determine how much more debt capital is required after first making the changes to the factors described below. Once the spreadsheet has been "calculated" for the first time after the factors have been altered, the peak requirement will have changed as a consequence of increased overall spending. The user must then decide the magnitude and timing of the loans required to balance equity with debt.

As a general rule, debt is used to finance the peak requirement of the farm being simulated. The peak requirement will always occur in the first two years of operations if debts are properly structured. To see how the total requirement has changed, the user must navigate to the bottom of the statement of SOURCES AND USES OF FUNDS (an appropriate address within the spreadsheet is CQ68). The row of ACCUMULATED NET REQUIREMENT indicates, by its positive peaks, when loan capital is needed to minimize these peaks.

For the scenario being described, the timing and magnitude of short term loans was changed to; $600,000, $500,000 and $500,000 for the first second and third quarters of year two, respectively. The long term debt was also increased to $500,000 in the last quarter of year two.

Because of these debts and other changes to the standard model, the total equity requirement for the large scale scenario increases to $2,090,000 and the peak debt level becomes $2,170,000. Thus, the same proportion of peak debt to equity as in the standard farm is retained.

17. MEDICINE AND VETERINARY SERVICES - The cost of treating fish will decrease slightly with increased scale because of the economies associated with the purchase of medicine, and with the acquisition of veterinary services.

The medicine and veterinary services factor is, therefore, decreased to $8.00 from $10.00 per tonne managed. The total bill will increase, due to more biomass being managed, but the charge per tonne is reasonably assumed to be about 20 percent lower.

17. WAGES - The cost of labour is assumed to stay the same, but because of the decision to include the purchase of feeders in this scenario, and because staff on a large farm can share the tasks more efficiently than on a small one, the factor for the number of tonnes delivered per day per man is increased.

Doubling of the labour productivity factor for this scenario reflects the ability of a computerized feeder system to replace labourers, and the benefits of specialization of labour that are possible on a large farm.

17. FUELS - The larger scale farm being modelled has more staff and an automated feeding system. The fuel bill for the farm must therefore reflect the greater consumption of fuels relative to consumption by the standard farm.

The necessary increase in the fuel consumption factor is lower than might be expected because of economies associated with a larger farm which can use boats and vehicles more efficiently. However, the presence of a large feeding system increases the incremental fuel costs to $8.00 per tonne, from $6.00.

18. MANAGEMENT SALARIES - Managing a large farm is presumed to require more time, and is therefore more expensive. The factor for management salaries can be left as is since the program will automatically increase the expense, because of the floating factor of $1,000 per month for each 50,000 smolts stocked. The monthly management expense increases to $10,000 when production is double that of the standard farm.

18. OFFICE AND TELEPHONE - There are presumed to be economies of scale associated with the acquisition of office and telephone services. The overall total will be higher, but the cost per tonne of biomass managed will be lower. Therefore, the factor has been reduced to $7.00, from $10.00.

18. LEGAL AND ACCOUNTING - Start-up charges are presumed to remain constant, while on-going charges are assumed to benefit from economies of scale. The factor is therefore reduced from $2.00 per tonne managed to $1.50.

18. MISCELLANEOUS FIXED COSTS - The charges for miscellaneous expenses are presumed to increase because of a greater variety of activities such as travel and meetings taking place. The factor has, therefore, been increased to 25 percent from 20 percent of other overhead expenses.

19. FEED STORAGE - More storage capacity will be required for the larger farm, but each tonne of requirement will cost less because of economies in the purchase of a larger barge than the one required by the standard farm. The factor for the feed storage charge has, therefore, been decreased to $1,750, from $2,000.

19. POWER SUPPLY - To accommodate more employees and a centralized feeding system, a larger power supply is needed than is required on the standard farm. The factor has therefore been increased from $15,000 to $20,000.

19. FEEDERS - As mentioned previously, the large scale farm is presumed to employ a centralized feeding system. This system increases the efficiency of labourers, but costs $120,000 to purchase and install.

19. MISCELLANEOUS FARM EQUIPMENT - The requirement for miscellaneous farm equipment will increase with increasing scale, but not in direct proportion to all other capital purchases. (A farm of any size needs only one net washer.) Therefore, the factor has been decreased to 15 percent, from 20 percent, to reflect a level of purchases that is a smaller proportion of a larger previous total.

A printout of the SUMMARY page for the large scale farm that has been described is provided in Figure One.

FIGURE ONE - Large scale farm.

SUMMARY STATISTICS

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DESCRIPTION OF FARM BEING MODELLED:
-50 percent debt
-Large farm, 10 km from road and 50 km from processing.
-Uses metal pens and computerized feeding, with accommodations and feed storage on a barge.
-Fish are taken away alive for processing.

PRODUCTION

	No.	TOTAL HARVEST		AVERAGE WEIGHT		PRODUC./SMOLT			FEED CONVERSION		AVE. SALE PRICE		
	smolts started	Round weight	Dressed weight	Round weight	Dressed weight	Round weight	Dressed weight	MORT.	(Feed/flesh) Round	Dressed	F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	300000	582815	518705	2.81	2.50	1.94	1.73	31 percent	2.10	2.36	$8.45	$6.39	$4,382,513
COHO	200000	300200	267178	2.10	1.87	1.50	1.34	28 percent	1.94	2.17	$6.57	$4.57	$1,754,386
COMBIN.	500000	883015	785884	2.52	2.24	1.77	1.57	30 percent	2.05	2.30	$7.81	$5.77	$6,136,899

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc.				OVERHEAD/kg of production				R.O.I.	PEAK REQUIREMENT (in millions $)	
		Feed	Process.	Trans.	Total	Fixed	Interest	Dep.	Total		Debt	Equity
$/KG	$6.33	$2.83	$0.95	$0.56	$5.05	$0.64	$0.25	$0.39	$1.28	28.4 %	2.08	2.17
$/KG		44.7%	15.1%	8.9%	79.8%	10.2%	4.0%	6.1%	20.2%	NPV	$1,900,000	

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The large scale farm described above has a total cost of production of $6.33 per kilogram of marketed fish, F.O.B. Vancouver. This is $0.36 per kilogram less than the result for the standard farm.

A detailed comparison of the summary pages from the large scale farm and the standard farm will reveal that all of the basic production statistics (production per smolt, mortality, sale price) remain the same between the two scenarios. This is because the basic biological assumptions have not been modified.

The internal rate of return for the large scale farm reflects the economies of scale that have been captured. It has risen from 18.8 percent for the standard farm to 28.4 percent while the net present value has risen from $475,000 to $1.9 million. The total investment has increased from $2,450,000 to $4,250,000.

DISECONOMIES OF SCALE - INCREASED CONVERSION RATE

It is unrealistic to assume that a farm can be doubled in size and retain all the benefits of a smaller operation. The scenario previously described only considered changes that were associated with the benefits of increasing scale. The obvious question is, "what can go wrong before the economies are lost"? The following scenario involves a modification of the large scale farm to determine how one common diseconomy can affect operating performance.

The first, and most common, source of diseconomy of scale in the fish farming industry, and one that is typically associated with the use of feeders, is an increase in the biological conversion rate. This increase in the conversion rate implies that feed is wasted and, that for every kilogram of feed consumed, there is a smaller incremental gain in biomass.

A uniform increase in the conversion rate is achieved by increasing the "CONVERSION RATE AS A PERCENT OF ASSUMED" factors for each species that appear on VARIABLES-1 page, on line 6. The timing and magnitude of debts must also be altered to maintain a 50 percent debt ratio.

An increase in the biological conversion rate of 10 percent results in an increase in the cost of production for the large scale farm from $6.33 to $6.67. Since the increased cost of production remains lower than that for the standard farm ($6.69), the economies of increasing scale are not completely lost if the feed conversion rate is 10 percent higher and all else remains the same. The peak requirement of the farm increased because of the increase in the "economic" feed conversion rate associated with a 10 percent increase in the "biological" conversion rate.

An additional $220,000 in debt and equity was required, resulting in a decrease in the return on investment to 23 percent from the previous 28 percent.

DECREASED FEED COSTS

Feed price discounts are available for farms with greater consumption. The large scale farm would certainly benefit from these discounts. A decrease in feed costs might also be associated with the choice of a lower priced feed rather than the premium varieties used on the standard farm. To consider either, or both, of these scenarios, a feed price decrease is required.

A uniform price decrease can be simulated by decreasing the factors for each species for FEED PRICE AS A PERCENT OF ASSUMED that appears on line 7 of VARIABLES-1, and by altering the debt level to maintain the desired level of 50 percent.

A feed price decrease of 5 percent results in a total cost of production of $6.50 per kilogram. This implies a savings of $0.17 per kilogram over the previous scenario. At the same time, the equity requirement decreases by $50,000, and the return on investment increases by 3 percent over the previous scenario. Price decreases, or discounts, are therefore desirable provided they are not associated with any side effects such as decreased conversion rates associated with lower quality feed.

HIGHER MORTALITY

Increased mortality is another possible diseconomy associated with large farms and with the purchase of lower priced feeds. The scenario described below considers the effects of increased mortality as a consequence of diseconomies of scale and of "savings" on feed purchases.

Uniform increase in the mortality rates throughout the production cycles is achieved by increasing the factor labelled MORTALITY RATE AS A PERCENT OF ASSUMED that appears on line 5 of VARIABLES-1. Again, it is necessary to rebalance equity and debt.

The scenario to be considered is a 50 percent increase in the mortality rates of the two stocks. This increase raises the overall mortality to 43 percent for the chinook, and to 42 percent for the coho. Such levels of mortality are below levels experienced by some farmers and are, therefore, realistic.

To provide a realistic scenario of increased mortality, it is necessary to change other cost factors to reflect expected operating conditions.

With higher mortalities occurring on the farm, the expense for medicine and veterinary services would increase in both absolute terms and relative to the biomass being raised during any period. Thus, the factor for medicine and veterinary services is increased from $9.00 to $12.00 per tonne managed.

This increase reflects an increase in the cost of managing the biomass under the higher mortality scenario and also compensates for a decrease in the biomass being raised. The higher mortality rate decreases the biomass being managed, resulting in a lower charge for medication relative to a healthy farm. Thus, increasing the medicine and veterinary services factor results in a more realistic picture.

The relationship between the labour required on the farm and the biomass managed must also be changed to account for the higher mortality rate. The labour requirement is related to the quantity of feed consumed. With increased mortality, the quantity of feed consumed would decrease. Since higher mortality rates do not correspond with less work on a farm, (because of diving and disposal) the labour factor, for tonnes fed per man per day, must be decreased from 1.5 to 1.25 to maintain a labour charge that is similar to that for the same farm having a lower mortality rate. (There would also be a lower expense for accommodations without increasing the labour efficiency factor).

The need to increase the labour factor provides a good example of one of the weaknesses of the model. Without careful consideration of how expenditures are automatically generated, the previous scenario and the current scenario would not represent the same farm. The reason for this is that the mortality rate increase would result in automatic savings in labour and accommodations that would not really occur.

To ensure that two scenarios are comparable in terms of capital purchases, it is necessary to override the automatic calculations for any expenditures in which the cost factors relate to the biomass being managed, and are not specifically altered by the user as part of the simulation.

FIGURE TWO - Large scale farm with increased conversion rate, decreased feed costs and increased mortalities.

SUMMARY STATISTICS

DESCRIPTION OF FARM BEING MODELLED:
- 50 percent debt, 10 percent higher conv., 5 percent lower feed costs and 50 percent higher mort. than std. farm.
- Large farm, 10 km from road and 50 km from processing.
- Uses metal pens and computerized feeding, with accommodations and feed storage on a barge.
- Fish are taken away alive for processing.

PRODUCTION

	No. smolts started	TOTAL HARVEST Round weight	Dressed weight	AVERAGE WEIGHT Round weight	Dressed weight	PRODUC./SMOLT Round weight	Dressed weight	MORT.	FEED CONVERSION (Feed/flesh) Round	Dressed	AVE. SALE PRICE F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	300000	479473	426731	2.79	2.48	1.60	1.42	43 %	2.46	2.76	$8.44	$6.38	$3,602,250
COHO	200000	250730	223150	2.09	1.86	1.25	1.12	40 %	2.20	2.47	$6.56	$4.57	$1,463,728
COMBIN.	500000	730203	649881	2.50	2.23	1.46	1.30	42 %	2.37	2.66	$7.80	$5.76	$5,065,975

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc. Feed	Process.	Trans.	Total	OVERHEAD/kg of production Fixed	Interest	Dep.	Total	R.O.I.		PEAK REQUIREMENT (in millions $) Debt	Equity
$/KG	$6.96	$3.11	$0.96	$0.58	$5.52	$0.71	$0.30	$0.42	$1.43	IRR	15.55%	2.09	2.01
$/KG		44.8%	13.7%	8.4%	79.4%	10.2%	4.3%	6.1%	20.6%	NPV	$502,000		

The cost of production for the large scale farm, with 42 percent mortality (50 percent higher), 10 percent higher conversion and 5 percent lower feed costs than on the standard farm, is $6.96 per kilogram of product, F.O.B. Vancouver. This level is $0.30 per kilogram higher than the standard farm scenario, which implies that all economies of scale have been lost.

As a consequence of the diseconomies, the internal rate of return is 16 percent compared to 28.4 percent for the large scale farm. As a result of a different cash flow, the net present value is $502,000 compared to $1.9 million.

INCREASED PROPORTION OF DEBT

It would be desirable to finance increases in the scale of a farm through increased debt, rather than by a balanced increase in debt and equity. While the option to do so is generally not available to most farmers, the effects of such leverage are of interest.

In the previous scenario, the total requirement was $4,100,000, with a 50 percent debt to equity ratio. If the debt ratio is increased to 75 percent (all long term debt), then the total requirement becomes $4,400,000, and the return on investment rises from 16 percent, for the previous scenario, to 22 percent. At the same time, the cost of production rises from $6.96 per kilogram to $7.34. The rise in the cost of production is entirely due to interest charges.

MULTIPLE FARM SITES

The type of farm described by the two previous scenarios is more likely to be part of a multi-site company than to exist as an individual farm. The largest farms currently in operation have been developed by large public companies which are attempting to capture all economies of scale.

The assumptions of conversion rate, mortality and feed costs that were used in the previous scenarios remain valid for a farm that is only one part of a large company. However, there are additional economies that can be realized by the even greater scale associated with multi-site companies. These savings stem from the ability to share overhead and the purchase and upkeep of equipment.

The simulation of the financial picture of a multi-site company requires several changes from the previous scenario. (To simplify comparison of the results with those of the standard farm, the debt level is returned to 50 percent.)

The changes required in the order they appear on the VARIABLES pages, for factors under headings 17 through 19 are as follows.

17. MEDICINE AND VETERINARY SERVICES - The cost of administering to the fish stocks would be decreased by having a veterinarian on staff, and by large purchases of medications. The cost factor is therefore reduced from $10 per tonne to $6 per tonne.

17. WAGES - Mid-level management tasks can be shared between sites, so the minimum labour cost is reduced to $2,000 per month.

The average cost for labourers also tends to be lower for the big multi-site companies and therefore, the monthly rate is decreased to $2,000 from $2,200.

17. FUELS - The consumption of fuels decreases because of savings from shared boating activity. The cost factor drops from $10 to $8 per tonne.

18. MANAGEMENT SALARIES - The use of a common administration centre results in lower senior management costs for an individual site. The management charge drops from $10,000 per month to $2,000.

18. OFFICE AND TELEPHONE - Having a common administration centre allows a decrease in the factor for office and telephone expenses for each farm site, from $7 per tonne to $2.

18. LEGAL AND ACCOUNTING - The start-up charges for a large public company would be high, but costs on a per farm basis would be low. The start-up charge is, therefore, lowered to $10,000 from $50,000.

On-going legal and accounting services, like other administration functions, would be centralized and the costs shared. The cost factor is, therefore, reduced to $.50 per tonne from the previous level of $1.50.

18. MISCELLANEOUS - As with other administrative functions, travel costs and similar charges will be minimized on a per farm basis. The factor is, therefore, reduced from 20 percent of previous expenses to 10 percent of previous expenses.

19. FEED STORAGE - Increased economies in purchasing result in an even lower cost per tonne of storage required. The factor is, therefore, dropped to $1,500 per tonne from $1,750.

19. ACCOMMODATIONS - In general, the publicly traded companies tend to provide lower cost accommodations than the average private company. The accommodations factor must, therefore, be dropped to $10,000 per man required, from $17,000, to reflect this.

19. DOCKS AND DECKS - The ability to share facilities between sites minimizes the need for a vast array of equipment at each site. This is true of docks and decks because such operations as net cleaning and repair become centralized. The cost factor for docks and decks is, therefore, reduced to 15 percent of the cost of feed storage, down from 30 percent.

19. BOATS AND TRUCKS - The multi-site companies have a lot of vehicles and boats, but typically fewer per farm than individually operated sites. The start-up charge for boats and trucks is, therefore, reduced to $15,000 from $40,000.

19. MISCELLANEOUS - One of the largest savings for multi-site companies arises when start-up costs, that have been capitalized, and equipment, such as net washers and rollers, are shared between sites. As a consequence of these savings, the factor for miscellaneous purchases has been reduced to $20,000 for the individual farm site's share of the costs of starting the company. The miscellaneous costs for general farm equipment, as a percent of previous purchases, is reduced from 15 percent to 10 percent (of a relatively low level).

FIGURE THREE - Large farm that is part of a multi-site company.

SUMMARY STATISTICS

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DESCRIPTION OF FARM BEING MODELLED:
-50 percent debt, 10 percent higher conv., 5 percent lower feed costs and 50 percent higher mort. than std. farm.
-Large farm that is part of a multi-site company, 10 km from road and 50 km from processing.
-Uses metal pens and computerized feeding, with accommodations and feed storage on a barge.
-Fish are taken away alive for processing.

PRODUCTION

	Number smolts started	TOTAL HARVEST Round weight	Dressed weight	AVERAGE WEIGHT Round weight	Dressed weight	PRODUC./SMOLT Round weight	Dressed weight	MORT.	FEED CONVERSION (Feed/flesh) Round	Dressed	AVE. SALE PRICE F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	300000	479473	426731	2.79	2.48	1.60	1.42	43 %	2.46	2.76	$8.44	$6.38	$3,602,250
COHO	200000	250730	223150	2.09	1.86	1.25	1.12	40 %	2.20	2.47	$6.56	$4.57	$1,463,726
COMBIN.	500000	730203	649881	2.50	2.23	1.46	1.30	42 %	2.37	2.66	$7.80	$5.76	$5,065,975

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc. Feed	Process.	Trans.	Total	OVERHEAD/kg of production Fixed	Interest	Dep.	Total	R.O.I.		PEAK REQUIREMENT (in millions $) Debt	Equity
$/KG	$6.62	$3.11	$0.96	$0.58	$5.41	$0.44	$0.39	$0.39	$1.21	IRR	25.06 percent	1.67	1.70
$/KG		47.0%	14.4%	8.8%	81.7%	6.6%	5.9%	5.8%	18.3%	NPV	$1,200,000		

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The total cost of production for the farm that is part of a multi-site company is $6.62 per kilogram. The economies of sharing equipment between farms, and of being able to spread out administration costs, allows the largest firms to bring their cost of production down to the rate of a well-run, moderate sized company ($6.69).

The large multi-site company has an advantage over a single farm site company in the return on invested equity. The standard farm has an estimated return of 19 percent. The large, multi-site company that benefits from all economies of scale, but also suffers from diseconomies, receives an estimated 25 percent return on invested equity.

ECONOMIES OF SCOPE

The last scenario in the series is of a large farm, part of a multi-site company, that benefits from vertical integration (scope). The economies of scope that are readily available to large, multi-site companies are in the areas of marketing, processing, smolt production and transportation.

To incorporate these additional economies into the simulation, a number of changes in factors are required. The timing and magnitude of loans must also be adjusted to maintain the 50 percent debt ratio.

9. TOP GRADE PRICE AS PERCENT OF ASSUMED - By having a marketing division, a fully integrated, multi-site company is expected to be able to receive a higher price for fish produced. To reflect this, the factor for the "top grade price as a percentage of the assumed" has been increased by 10 percent. All revenues are, therefore, increased by 10 percent.

11. PROCESSING COSTS - With an in-house processing plant, the costs of processing would be related to the variable costs of operating the plant, and to the capital costs of initially building and outfitting the plant. The factors for processing costs (x3) have been decreased by one third. This level of decrease is a reflection of the savings that might be associated with eliminating the profit and overhead charges that would be paid to a privately run plant, while retaining the variable costs of processing.

13. TRANSPORTATION - By providing their own transport services, an integrated company would be able to reduce the per unit charges for transportation down to the variable costs (labour, maintenance and fuel) associated with providing the services, plus the capital cost of the initial purchase. The per unit transport cost for feed is therefore reduced to $.01 per kilogram consumed, live haul transport is reduced to $0.07 per kilogram of fish marketed, and transport of fish to Vancouver is reduced to $.09 per kilogram of fish marketed.

17. SMOLTS - The variable costs of producing smolts are relatively low because of economies of scale available to large private hatcheries. The purchase price of smolts has therefore been reduced to 25 percent of the original level, to reflect the cost of eggs, labour, vaccines and feed.

17. WAGES - With more operations being performed by the farm staff, such as assisting in feed transports, etc., the labour efficiency decreases. The factor for the number of tonnes fed per day per man is, therefore, reduced to 1 from 1.25.

18. MANAGEMENT SALARIES - The need to organize a greater number of operations will increase the cost of management to each farm. The charge per month must therefore be increased, from $2,000 to $3,000.

18. OFFICE AND TELEPHONE - There would be a dramatic increase in the costs associated with the administrative office if it is to incorporate the needs of a marketing division. The factor for office and telephone was, therefore, increased to $20 per tonne, representing an annual total of $95,000.

18. LEGAL AND ACCOUNTING - The start-up charge for legal and accounting services is presumed to remain high for an individual farm. The floating charge is set at a rate of $2 per tonne, up from $0.50, to reflect the more complicated nature of the vertically integrated organization.

The last change made to the program is to add in a large capital expenditure, representing the farm's portion of the costs of establishing the processing plant and hatchery, and of purchasing transport vessels. For the purposes of this extraordinary expense, $400,000 was added directly into the statement of SOURCES AND USES OF FUNDS, under miscellaneous capital purchases, in the last quarter of the first year of operations.

FIGURE FOUR - Large farm that is part of a vertically integrated multi-site company.

SUMMARY STATISTICS

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DESCRIPTION OF FARM BEING MODELLED:
- 50 percent debt, 10 percent higher conv., 5 percent lower feed costs and 50 percent higher mort. than std. farm.
- Large farm that is part of a multi-site company, 10 km from road and 50 km from processing.
- Uses metal pens and computerized feeding, with accommodations and feed storage on a barge.
- Fish are taken away alive for processing.

PRODUCTION

	No. smolts started	TOTAL HARVEST		AVERAGE WEIGHT		PRODUC./SMOLT			FEED CONVERSION (Feed/flesh)		AVE. SALE PRICE		
		Round weight	Dressed weight	Round weight	Dressed weight	Round weight	Dressed weight	MORT.	Round	Dressed	F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	300000	479473	426731	2.79	2.48	1.60	1.42	43 %	2.46	2.76	$8.29	$7.65	$3,962,475
COHO	200000	250730	223150	2.09	1.86	1.25	1.12	40 %	2.20	2.47	$7.22	$5.70	$1,610,098
COMBIN.	500000	730203	649881	2.50	2.23	1.46	1.30	42 %	2.37	2.66	$8.57	$6.98	$5,572,573

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc.				OVERHEAD/kg of production				R.O.I.	PEAK REQUIREMENT (in millions $)	
		Feed	Process.	Trans.	Total	Fixed	Interest	Dep.	Total	_	Debt	Equity
$/KG	$6.00	$3.11	$0.67	$0.18	$4.45	$0.69	$0.39	$0.47	$1.56	IRR 44.97 %	1.87	1.70
$/KG		51.9%	11.1%	3.0%	74.1%	11.5%	6.5%	7.9%	25.9%	NPV $3,400,000		

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The results indicate that a large, fully integrated fish farming company, able to provide services in-house as effectively as these could be provided by others, could have production costs of $6.00 per kilogram, F.O.B. Vancouver, before sales commissions.

Shareholders in publicly traded companies would be happy to know that the return on investment, assuming that 10 percent higher fish prices are obtained, is estimated at 45 percent.

TRANSPORTATION COSTS

The last example of how the program can be manipulated will illustrate the effects of increased transport costs on the cost of production. For the purposes of this final scenario, the standard farm model will be used and modified, rather than attempting to introduce yet another variation of the scenarios provided above.

The transport cost increases to be used are those expected for a farm that is no more "remote" than the standard farm, in terms of distance from a commercial centre, but that is more remote from the manufacturers of feed and equipment and from the fish markets. This would be equivalent to a farm located in the central coast region.

To reflect the increases in costs associated with operations in the central coast region, the transport cost for feed per kilogram is doubled from the standard farm rate of $0.05 per kilogram, to $0.10. In addition, the cost for live haul of fish is increased by 50 percent, to $0.50, to reflect the lack of appropriate facilities in the central coast region.

The charges for the transport of packaged fish to Vancouver is presumed to be twice as high as that for the standard farm.

The transport premium factor for COST OF GOODS SOLD is set at 10 percent. This premium only increases the costs of smolts, labour, fuel and medicine, which would all be more expensive to obtain in a remote location.

Under the category of FIXED COSTS, the only anticipated increase in expenses is a rise in the cost of management, to $8,000 from $6,000 per month, to reflect the cost of operating a farm in an area with less infrastructure that in southern B.C.

The transport premium factor for CAPITAL PURCHASES is set at 3 percent, to reflect the increased cost of acquiring goods in the central coast region, or of having them transported from southern B.C.

FIGURE FIVE - Standard farm operating in central coast region.

SUMMARY STATISTICS

DESCRIPTION OF FARM BEING MODELLED:
-50 percent debt.
-Moderate sized farm, 10 km from road and 50 km from processing.
-Uses metal pens and computerized feeding, with accommodations and feed storage on a barge.
-Fish are taken away alive for processing.

PRODUCTION

	No. smolts started	TOTAL HARVEST		AVERAGE WEIGHT		PRODUC./SMOLT			FEED CONVERSION (Feed/flesh)		AVE. SALE PRICE		
		Round weight	Dressed weight	Round weight	Dressed weight	Round weight	Dressed weight	MORT.	Round	Dressed	F.O.B. Van.	Farm Gate	REVENUES
CHINOOK	150000	291408	259333	2.81	2.50	1.94	1.73	31 %	2.10	2.38	$8.45	$6.28	$2,191,257
COHO	100000	150100	133589	2.10	1.87	1.50	1.34	28 %	1.94	2.17	$6.57	$4.47	$877,193
COMBIN.	250000	441508	392942	2.52	2.24	1.77	1.57	30 %	2.05	2.30	$7.81	$5.66	$3,068,449

FINANCIAL

	Total cost of produc.	COST OF GOODS SOLD/kg of produc.				OVERHEAD/kg of production				R.O.I.	PEAK REQUIREMENT (in millions $)	
		Feed	Process.	Trans.	Total	Fixed	Interest	Dep.	Total	—	Debt	Equity
$/KG	$7.13	$2.83	$0.95	$0.88	$5.50	$0.85	$0.33	$0.48	$1.84	IRR 12.04 %	1.34	1.30
$/KG		39.7%	13.4%	12.4%	77.1%	11.9%	4.6%	6.5%	22.9%	NPV $120,000		

The total costs of production for farms operating in the central coast region is $7.13 per kilogram and the return on investment drops to 12 percent.

THE EFFECTS OF LIFE HISTORIES ON THE COST OF PRODUCTION

A discussion of the factors affecting the cost of production on a farm would be incomplete without a discussion of the effects of raising different species or varieties of fish. The cost of production is significantly affected by the life history of the fish being farmed. Astute readers may have already noticed that the average sale price for the coho is lower than the average cost of production for the standard farm. The discussion that follows attempts to explain this difference.

A complete discussion of how different life histories alter the cost of production is outside the scope of this report. However, a brief overview will begin to explain how the life history of a given species affects its suitability for farming.

At present, there are nine varieties of "salmon" being raised on sea farms in B.C. These are:

1. Regular sex chinook,
2. Hormonally feminized chinook,
3. Mono-sex milt feminized chinook,
4. Accelerated coho (S0),
5. Sterilized accelerated coho (S0),
6. S1 coho,
7. S1 Atlantic salmon,
8. S2 Atlantic Salmon, and
9. Rainbow trout.

To complicate things further, the nine varieties may each be subdivided into wild and domestic strains, with numerous "source rivers", and differing numbers of generations in captivity. The reasons for the proliferation of varieties and sexual treatments relates to life histories.

To understand how life histories have motivated this proliferation, it is necessary to appreciate the market forces facing the farmed salmon industry, and how the market demand conflicts with the biology of the fish being raised. Essentially, the process of domestication is an attempt to make the fish conform to market demand as efficiently as possible.

Generally, larger fish realize a higher selling price. Therefore, when choosing a species to farm, one considers what average weight can be achieved, at what cost, and when. A fast growing fish that could attain any desired weight, given enough time, would be ideal.

A large average weight is not only desirable in salmon farming, it is essential. The premium, fresh salmon market demands a fish that can be filleted or cut into portions. A weight of 4 pounds dressed (2 kilos round weight) is considered to be the minimum size for this market. A limited market for smaller size categories exists at a lower sale price. Unfortunately, processing costs for small fish are higher per unit weight than for large fish so smaller size fish are even less profitable.

In addition to large size, the premium salmon markets require year round supply. The fundamental strength of salmon aquaculture lies in the ability of farmers to produce fresh salmon during the off-season of the commercial fisheries. Shortages during the winter result in the highest prices occurring at those times. To be independent of the commercial fisheries, and to obtain the highest prices possible, farmed salmon must be sold during the winter months.

The market demand for four pound and preferably larger fish, along with the normal distribution of sizes which occur within a population, makes it essential for salmon farmers to raise their fish to average weights of almost three kilos. Superfically, the solution to this problem is to continue growing the fish until the desired size is attained. However, aside from the issues of increased risk and cost of capital, all of the salmonid species have a narrow production window, which prevents this "solution" from working.

It is well known that salmon spawn after a few years and then die (in the case of Pacific salmon), or become disfigured (in the case of trout and Atlantic salmon). This process is accelerated in the food rich environment of the salmon pen. As a result, salmon can only be reared for a limited period of time. The time constraints imposed by life histories have been a major problem for the industry. In general, the problem is to grow the salmon fast enough to reach the desired weight for the market "window", before the fish must be harvested due to sexual maturation.

THE HISTORY OF STERILIZED COHO

A discussion of the history of accelerated, sterilized coho provides a good example of the factors that influence the choice of species by the industry.

Until recently, coho were the principal fish being farmed. This was a consequence of the abundance of wild eggs, a high market price for wild caught coho, and good growth rates up to the pan-sized salmon (250-400 grams) that were the bulk of production. When the modern push towards sea-pen rearing of large salmon began, the coho were a natural candidate.

In order for the salmon aquaculture industry to grow, the supply of smolts had to increase rapidly. Unfortunately, coho smolts typically stay in fresh water for 1.5 years before entering salt water, (and are therefore referred to as S1 coho). This long fresh water phase restricted the ability of hatcheries to produce smolts quickly so accelerated coho (referred to as S0 coho) were produced, instead of natural age coho (S1). Accelerated, or S0 coho are regular coho reared in artificially heated water to "accelerate" the fresh water phase from roughly 16 months to 6 months.

Regular S1 coho are ready to enter the sea in late March or April, while accelerated coho enter the sea almost a year earlier, but in the summer. This reduces their growing season. Considering the time and costs saved in the hatcheries, however, starting the fish in the sea a few months later seemed like a reasonable trade-off.

After entering the sea in the spring, coho, whether accelerated or not, mature during their second fall in the sea (see graph number 1). A coho stocked in the sea in August only has 12 months to grow to market size, before it becomes discoloured, due to sexual maturity, and dies. The practice of accelerating coho reduced smolt prices but narrowed the grow-out period (production window) for sea farmers. As a result, accelerated coho only reached marketable weights by the late summer when they had to compete in the marketplace with wild salmon. The short production window resulted in a very short marketing window, and often fish were harvested before they reached the desired size categories.

One solution to the problem of sexual maturity forcing the farmer to sell at a bad time, and low average weight, was to sterilize the fish. Sterilization technology was, therefore, transferred from the salmon enhancement sector to salmon farming.

Sterilization was accomplished by bathing the eggs and alevins in hormones, at predetermined intervals. Sterilized, accelerated coho were expected to have an unlimited production window. The possibilities seemed limitless.

Millions of sterilized, accelerated coho were stocked in sea cages and, almost without exception, they failed. The sterilization process slowed growth, deformed fish, made them more susceptible to disease and was only marginally effective at preventing sexual maturity. Instead of being a longer lived variety they turned out to be a problem. Sterilized coho are almost non-existent now.

The interplay between life histories, market conditions and rapid growth of the industry led to some very depressing results for salmon farmers over the last few years. Now the industry is able to choose its varieties with some knowledge base, but as yet there is no real consensus about which fish to raise.

REGULAR SEX CHINOOK

Chinook have become the species of choice in B.C. because their life history is more conducive to farming than that of the coho. Most members of a chinook population can be held for two full years in the sea. However, the fact that there are feminized varieties is evidence that the life history of the chinook is not ideal.

Salmon typically spend only a few months in fresh water before entering salt water, at a weight of approximately 7 grams. As a consequence of the short fresh water phase, the smolts can be produced relatively cheaply. Prices are currently as low as $0.35 for large orders, but have been as high as $1.00 when supply was limited.

In the past year, the supply of eggs from farmed fish (domestic eggs) was sufficient to supply the industry's needs for the first time. This abundance has permitted a radical swing away from all varieties of coho.

The chinook life history permits two winters of growth in the sea for most members of a population. A smolt stocked in early spring of 1989 will not mature until August of 1991, after 26 to 28 months in the sea, depending on when the smolts were delivered to the farm (see graph number two). What prevents chinook salmon from being the ideal farm fish is relatively slow growth rates, and precocious maturing (jacking) of some of the males in the population.

The slower growth rate means that chinook salmon reach a marketable size (ie. 2.5 kg average weight) after almost 20 months in the sea. As a result, all chinook must be sold in late Winter or early Spring to avoid conflict with the wild fishery. In 1989, with the Chilean harvest in February and March, the prices remained low. Many farmers held back their production and were forced to sell into a flooded market at poor prices. The notion of a window for farmed B.C. salmon may have to be abandoned in favour of continuous marketing throughout the "production" window.

A shorter than ideal production window would not be so critical if jacking did not cut further into profits. Jacking occurs in the second fall after 14 to 16 months in salt water. Anywhere from 5 percent to 40 percent of a population may "jack" and these are typically the largest members of the chinook population. Jacks can attain an average weight of 2.5 kilograms, while the remainder of the population is only at a 1 kilogram average.

In the past, some farmers let the jacking portion of their chinook populations die in the nets. This amounted to losses of from 8 percent to 40 percent of the number stocked, and included all the largest fish at the time. The results were catastrophic for some.

The recognition that jacks could, and must, be separated from the rest of the stocks has forced farmers to handle their fish during the worst possible time of the year, when water temperatures are at their peak. This handling results in some additional mortality, but allows the bulk of the jacks to be sold.

To date, there is no perfect way to separate (grade out) the jacks from the rest of the population. There are many techniques, most of which depend on separation by size, and the assumption that the jacks are the largest members of the population.

An extra cost associated with jacking comes from the fact that grading by size results in some fish that would not have jacked being harvested, and some that will jack, not being harvested. The ones that would not have jacked would have been the premier production fish, after the full growth cycle. The ones that were not harvested, but do jack, are expensive losses and create additional work and disease problems as they are removed over a prolonged period. Grading is not only labour intensive, but ultimately results in a lower average weight for the remaining fish than it would have if the jacks had been left to die.

HORMONALLY FEMINIZED

The obvious solution to the problem of jacking is to somehow eliminate it. While genetic selection may ultimately provide a jack-free variety, in the short run the industry has turned again to hormones.

Basically only the males mature early so a population without males would not have a jacking problem. The sterilization process was, therefore, modified to produce "hormonally feminized" populations.

Feminization is a less harsh treatment than sterilization, because only a single hormone bath is required rather than several. The feminization process is less destructive but still slows growth. This slowing narrows the marketing window even more than for regular chinook. In addition, the feminization process is seldom 100 percent effective so jacking may still occur at a level that justifies grading. The farmer is then faced with smaller fish that are nearly as troublesome as regular sex chinook.

MONOSEX MILT FEMINIZED

In addition to feminization through hormonal baths, a technique has been developed to produce males with genetically female milt (sperm). These males produce only female offspring which are, therefore, jack-free populations.

The use of monosex fish was originally adopted by the salmon farming industry to ensure that a population being held for egg production (broodstock) was composed of only females. A normal population would contain an unnecessarily high number of males. The successful growth and survival of the broodstock fish generated interest in monosex milt fish as production fish.

In general, feminization through monosex milt has been successful. Farmers report that growth rates of the monosex fish compare well with the non-jacking portion of regular sex stocks. In addition, the stocks are not particularly susceptible to disease, and can always be used for egg production, if not for slaughter.

Monosex chinook have been used as the principal production fish for the standard farm, because of their suitability for farming and a growing interest in them throughout the industry.

To date, monosex milt has been supplied by the Department of Fisheries and Oceans West Vancouver Laboratory, but there is an increasing availability within the industry. The process by which monosex milt is produced takes a full generation (3 to 4 years). Therefore, production of monosex eggs will lag behind initial demand by a number of years. The authors believe that recognition of the value of monosex milt will soon make it abundant, and that monosex production fish will become the norm.

Monosex chinook populations do not have a jacking problem, and therefore the growth curve of a population rises smoothly, without fluctuations caused by jacking. In addition, the elimination of grading allows monosex fish to be left untouched during the sensitive summer months, resulting in lower overall mortality. They would be an excellent farm fish, if they achieved better growth rates.

With current growth rates, it is only possible to attain an average weight of 2.5 kilos by March of the second year in sea water. Domestic Atlantic salmon, by comparison, can average as much as 7 kilos in the same period. As a consequence of the relatively slow growth, it is not yet possible to sell chinook year round. The months from October to January are being missed. Without filling this production gap, the B.C. salmon farming industry will be limited in its ability to compete with Norway, and will not be able to obtain the highest available prices for farmed fish.

CHINOOK VERSUS COHO

Re-inspection of the results for the standard farm will reveal that the coho received an average sale price that was lower than their average cost of production. This implies that coho are unprofitable even though they are cheaper to raise than chinook because of lower mortality. The standard farm would not be better off without the coho, however, because the coho harvest contributes to overhead charges. The marginally profitable results for the coho is a consequence of a narrow late summer marketing window.

For reasons that have been explained, the accelerated coho on the standard farm were held for as long as possible, to get them to the profitable size ranges. By the time the coho harvest had to begin, in August of their second summer in the sea, the coho were only 2 kilos. This average weight results in a large percentage of fish in the smaller weight categories. In addition, the late summer harvest competes with the wild fishery, and prices are reduced even for larger sizes of fish. The net result is a crop which contributes to overhead, but is only marginally profitable, at best.

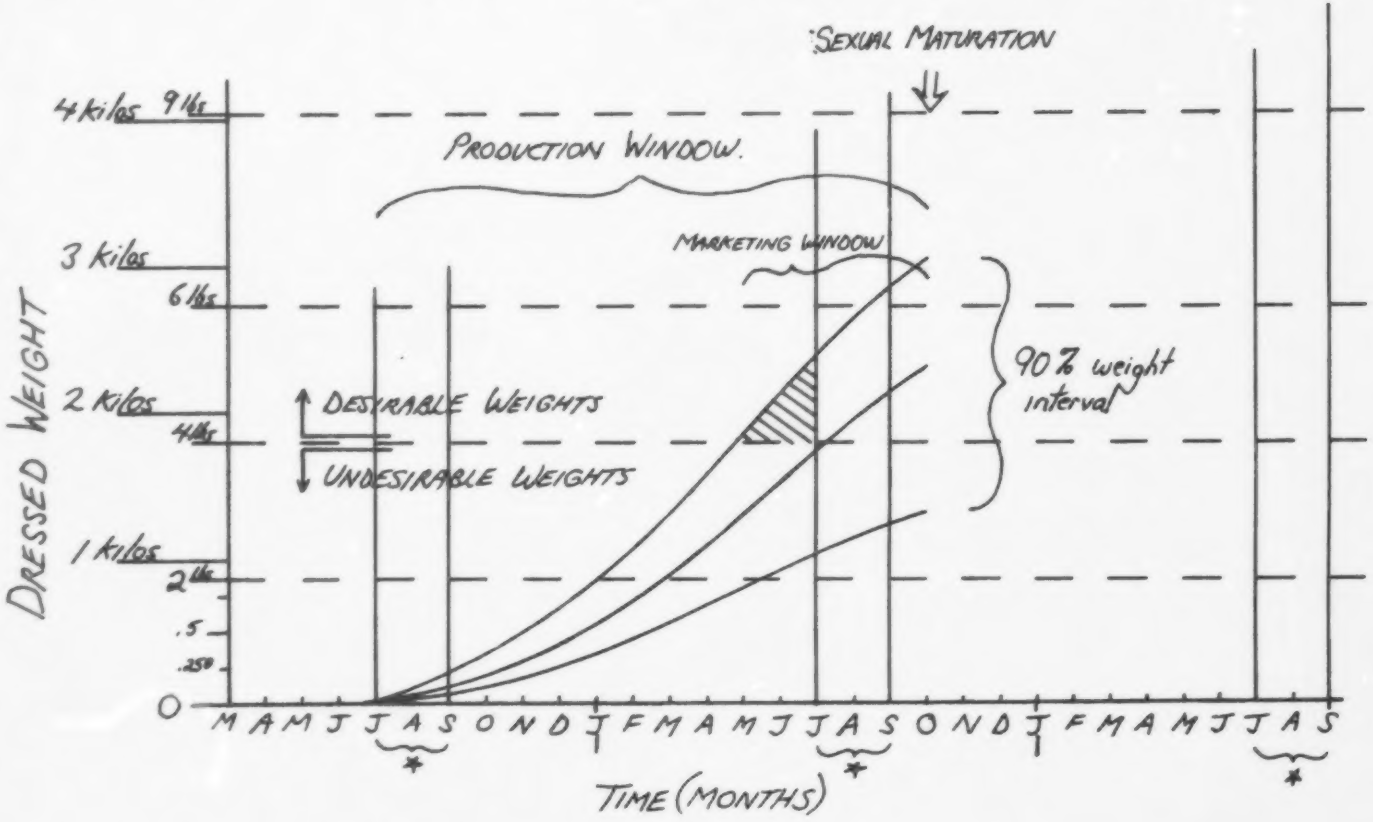
GRAPH ONE illustrates what the terms "marketing window" and "production window" mean. The cross-hatched area highlights the small overlap between the accelerated coho production curve and the desirable months for marketing. A brief production window results in the majority of the fish reaching the desirable size ranges only during the late summer, when the commerical fishery lowers sale prices.

In contrast to the accelerated coho, the monosex chinook that were raised on the standard farm have a two year production window, and growth rates that result in a seven to nine month marketing window. Sales can begin as early as February for top graded fish, and can continue until September, if desired. For the standard farm, the harvest ended in June, before the wild harvest was presumed to lower prices. Because of a wider marketing window, chinook is more profitable, despite more continuous mortality and a higher overall mortality rate, than coho.

GRAPH TWO illustrates the production history for monosex chinook. The production and marketing windows are much longer than for accelerated coho. The cross-hatched area represents the overlap between the production curve and desirable months for marketing.

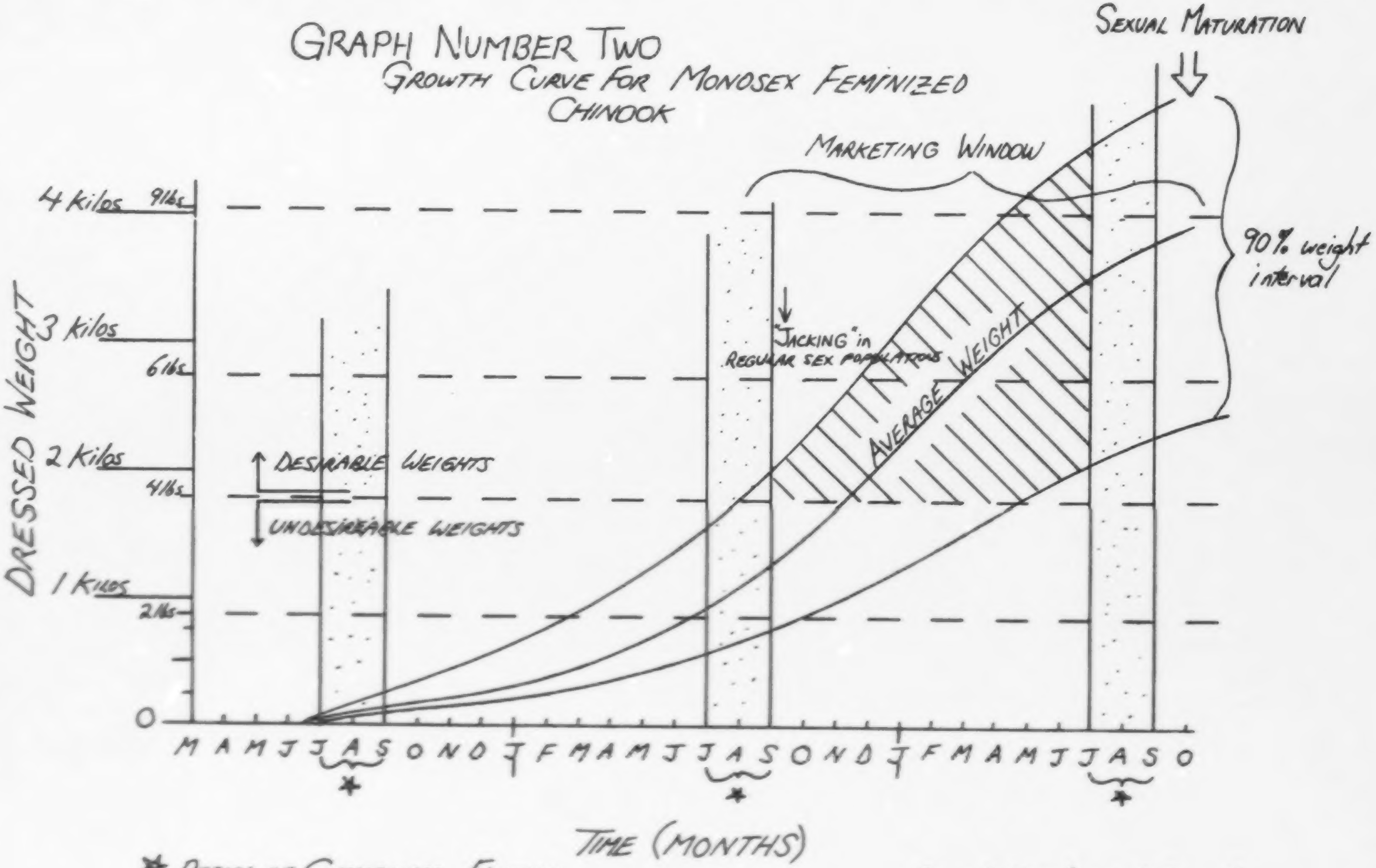
Slower growth than for coho, in combination with a longer production window, make monosex chinook a better variety of fish for farming in British Columbia.

GRAPH NUMBER ONE
GROWTH CURVE FOR ACCELERATED COHO (S.)



* PERIOD OF COMMERCIAL FISHERY.

BRIAN D. EGAN (AFTER D. SINCLAIR)



GRAPH NUMBER TWO
GROWTH CURVE FOR MONOSEX FEMINIZED CHINOOK

★ PERIOD OF COMMERCIAL FISHERY

BRIAN D. EGAN (AFTER D. SINCLAIR)

COST OF PRODUCTION BY VARIETY OF FISH RAISED

In order to more clearly illustrate how life histories affect the average cost of production on a farm, a number of different varieties of fish have been raised on the standard farm.

Table two summarizes the results of estimates of the cost of production for some of the varieties of fish that are currently being raised on B.C. salmon farms. The examples are for farms having a peak requirement of 2.5 million dollars, one half of which is acquired through debt. All other cost and production factors, such as net pen dimensions and prices, remain the same as for the standard farm.

TABLE TWO - Cost of production for single species farms, with total requirement of $2.5 million (50 percent debt).

STOCK TYPE	Cost of production (Vancouver)	Total dressed harvest	Ave drsd. weight harvested	Mortality rate	Drsd. prod. per smolt stocked	Economic feed conversion	Average sale price
ACCELERATED COHO (SO)	$7.03	255000	1.87	28 %	1.34	2.17	$6.57
REGULAR AGE COHO (SI)	$6.85	260000	1.85	25 %	1.38	1.97	$7.45
REGULAR	$7.28	300000	2.50	36 %	1.61	2.46	$8.45
MONO SEX	$7.00	320000	2.50	31 %	1.73	2.36	$8.45
ATLANTIC SALMON (SI)	$7.76	250000	3.92	30 %	2.76	2.10	$8.56

1. 10 percent losses due to unavoidable jacking
2. 5 percent losses due to unavoidable jacking
3. $3.50 per smolt

The results of the single species analysis are surprising. The costs of production for accelerated coho and monosex chinook are individually higher than for the standard farm with the two species combined. This result is the consequence of the single species farms having lower total production than the combined species farms, and therefore having fewer economies of scale. The increased average cost of production for the two species, raised separately on the standard farm, is the consequence of increased fixed costs per kilo of product produced.

In the analysis, the jacking rates for both the regular age coho and the regular sex chinook were kept to low levels, to reflect the fact that most jacks can be, and are, sold. The increased jacking mortalities represent losses of fish that were too small to harvest, or were lost despite grading.

The production results for the regular age coho were not very different from the accelerated coho. However, the regular age coho have a longer production window, and can be sold at a reasonable weight before the wild harvest begins. The sale price is therefore high, relative to the accelerated coho, and so the profitability is improved.

Atlantic salmon have a very wide and desirable marketing window due to rapid growth rates. In the analysis presented, it was assumed that the harvest began during the second September that the fish were in the sea, and continued for four months. The average weight harvested was therefore lower than it could have been.

The high cost of production for the Atlantic salmon is due to the very high smolt price. If reported mortality rates of only 15 percent can be routinely achieved, rather than the 30 percent used to generate the results above, then the high smolt price for Atlantic salmon would not be a barrier to their being the most profitable variety of salmon to raise in B.C.

CONCLUSION

This report attempts to define a standard farm and then demonstrate the variability between farms arising from the many differences between them. The term "standard farm", rather than "average" or "typical", is intentional. The standard farm is a well run and equipped farm of a good size that the authors believe to have production costs that are low compared to the industry average. Thus, it is a good starting point to model the wide variety of other scenarios that farms are facing.

The computer model on which this report is based allows the user to change assumptions by changing variables and factors. This flexibility is what enables the model to represent the variety of approaches, technologies, scope and scale that currently make up the industry.

The scenarios presented in this report illustrate the variation in production costs and profitability that can be expected between industry participants. The model predicts a range in production costs within the industry of $6.0 to $8.0 per kilogram, with an average of approximately $7.0 per kilogram. This is for product which is dressed, boxed and delivered to Vancouver but does not include mark-ups or commissions.

The profitability of salmon farms is estimated to range from a loss to returns on invested equity of 45 percent. The average return on investment is estimated to be between 15 and 20 percent.

An important conclusion to be drawn from this report is the effect of the variety of salmon being raised on cost of production and farm viability. The single most important factor affecting the operating results between companies is the life history of the fish being farmed. Estimates made of the cost of production that do not specify the variety of fish being farmed, are misleading. In an industry with a wide range of fish and technology options, it is necessary to know what is being raised, as well as how, if operating results are to be compared.

A constant "reinvention of the wheel" occurs in the industry because there is no formal avenue for sharing techniques and technology. Industry participants are willing to provide the information to a central agency willing to accumulate, analyze and present it. A concerted effort, on the part of industry and government, to summarize and distribute information on production results according to species, sexual treatments, and husbandry practices would be extremely beneficial. After five fitful years of developing in the dark, the industry needs information, correlated with successes and failures, to enable good fish culture and management practices and improve the performance of the farms. The collective experience of the industry can then be used as the basis for future management decisions by both large and small firms.

OPPORTUNITIES FOR ADDITIONAL WORK

This model and the accompanying report have been developed to allow the user to ask "what if" questions to facilitate decision making and analysis of the farmed salmon industry.

In the constantly changing environment facing the industry the model provides a tool for quickly analyzing actual or expected changes. It is, however, a complex industry with many economic, biological and technical questions. Thus, it may be beneficial to model scenarios which require some additional research of industry performance and significant changes to the model. A few scenarios which might be appropriate for additional contracts are:

1) The Atlantic salmon and/or rainbow trout farm in British Columbia.

This could be very important if industry participants decide to move a significant part of their production to other species. The impact of extensive farming of these species on wild salmon stocks could be addressed relative to the economic benefit of doing so.

2) The land-based salmon farm.

At current prices it seems unlikely that a land-based farm could be economical. However, there are significant technical and environmental advantages. It would be fairly easy to determine what price levels and biological developments would be required to allow economically feasible land based salmon farms.

3) The small or family farm and/or the so called super farm.

Although significant changes in scale can be readily accommodated by the model, these two extremes would require careful review of the assumptions and the operating procedures. In particular, a move towards superfarms could be viewed as the answer to the farm salmon price squeeze that is currently affecting the industry. Government support for this move may well be requested and this should be analyzed for its true economic impact on the industry. Specifically, do the economies of scale out-weigh the diseconomies.

4) Other species of finfish.

Black-cod, Halibut and other "cod" species are now, or soon will be, technically feasible as farm raised fish. Is the current farm technology capable of bringing these species in to economic production?

5) The salmon farming industry as a whole.

Analysis of the industry as a whole could be undertaken using the same format with average or accumulated variables as appropriate. Thus, one would model on the basis of expected total number of smolts in a given year, and use average values for the variables and factors.

This project would require collection of considerable information from co-operative farms and the development of industry average values for growth, mortality, feed conversion and other values for the variables of the model. It would be very useful for examining the economic impact of changes in the technological, financial and biological environment for the industry.

```
STANDARD FARM MODEL                                                                                               VARIABLES-1
                                                                                                                        of 3
 ============================================================================================================================
 ¦¦DESCRIPTION OF FARM BEING MODELLED:  50% debt
 ¦¦  Moderate sized farm, 10 km from road and 50 km from processing
 ¦¦  Uses metal pens, no feeders, accommodations and feed storage on barge.
 ¦¦  Fish are taken away alive for processing.
 ============================================================================================================================

   VARIABLES                             CHINOOK    COHO         ¦¦      STATISTICS         CHINOOK      COHO      COMBINED
   ---------                             --------¦--------       ¦¦      ----------       -----------------------------------
1. NUMBER OF SMOLTS STOCKED:             150000  ¦ 100000        ¦¦A. TOTAL HARVEST:                 ¦            ¦
                                                 ¦               ¦¦      round weight         291408 ¦     150100 ¦    441508
2. AVE.WGT. AT WHICH HARVESTING BEGINS:    2.10  ¦   1.90        ¦¦      dressed weight       259353 ¦     133589 ¦    392942
                                                 ¦               ¦¦                                  ¦            ¦
3. PERCENTAGE SOLD EACH MONTH:               20% ¦     50%       ¦¦B. AVE. HARVEST WGT.:             ¦            ¦
                                                 ¦               ¦¦      round weight           2.81 ¦       2.10 ¦      2.52
4. GROWTH AS % OF ASSUMED:                  100% ¦    100%       ¦¦      dressed weight         2.50 ¦       1.87 ¦      2.24
                                                 ¦               ¦¦                                  ¦            ¦
5. MORT. RATE AS % OF ASSUMED:              100% ¦    100%       ¦¦C. PROD./SMOLT STOCKED:           ¦            ¦
                                                 ¦               ¦¦      round weight           1.94 ¦       1.50 ¦      1.77
6. CONVER. RATE AS % OF ASSUMED:            100% ¦    100%       ¦¦      dressed weight         1.73 ¦       1.34 ¦      1.57
                                                 ¦               ¦¦                                  ¦            ¦
7. FEED PRICE AS % OF ASSUMED:              100% ¦    100%       ¦¦D. MORTALITY                      ¦            ¦
                                                 ¦               ¦¦      overall                  31%¦         28%¦        30%
8. % DOWNGRADES AS % OF ASSUMED:            100% ¦    100%       ¦¦      no. pieces lost       46399 ¦      28385 ¦     74784
                                                 ¦               ¦¦      weight lost           39561 ¦      11781 ¦     51342
9. TOP GRADE'S PRICE AS % OF ASSUMED:       100% ¦    100%       ¦¦                                  ¦            ¦
                                                 ¦               ¦¦E. FEED CONSUMPTION:              ¦            ¦
10.DOWNGRADE'S PRICE AS % OF TOPGRADE:       50% ¦     50%       ¦¦      total consumed       613223 ¦     290447 ¦    903670
                                                                 ¦¦      total expense      $749,392 ¦   $362,445 ¦$1,111,837
11.PROCESSING WGT. LOSSES AND COSTS PER KG OF FINISHED PRODUCT:  ¦¦      average price         $1.22 ¦      $1.25 ¦     $1.23
                               vgt.loss   bleed   gutting  pack. ¦¦      round conv. rate       2.10 ¦       1.94 ¦      2.05
                    0 TO 1 KG  ¦   11.00% $0.25   $0.70    $0.30 ¦¦      dress.conv. rate       2.36 ¦       2.17 ¦      2.30
               1 KG TO 2.5 KG  ¦   11.00% $0.22   $0.55    $0.27 ¦¦      cost/kg of dress.           ¦            ¦
              2.5 KG AND OVER  ¦   11.00% $0.20   $0.40    $0.24 ¦¦         fish produced      $2.89 ¦      $2.71 ¦     $2.83
                                                                 ¦¦                                  ¦            ¦
12.SALE PRICES FOR TOP GRADE (F.O.B. VAN., CLEANED AND PACK.):   ¦¦F. PROCESSING:                    ¦            ¦
                               ¦ ACTUAL PRICES  ¦¦ PRICES USED   ¦¦      ave.wgt.reduc.           11%¦         11%¦        11%
       WEIGHT CATEGORY         ¦chinook    coho ¦¦chinook  coho  ¦¦      total cost         $235,820 ¦   $138,933 ¦  $374,753
   UP TO 1 KG (UNDER 2 LBS)    ¦   $5.50  $5.50 ¦¦  $5.50  $5.50 ¦¦      cost/kg of dress.           ¦            ¦
   1 TO 2.0 KG (2 TO 4 LBS)    ¦   $6.60  $6.60 ¦¦  $6.60  $6.60 ¦¦         fish produced      $0.91 ¦      $1.04 ¦     $0.95
   2 TO 3 KG (4 TO 6 LBS)      ¦   $8.40  $8.40 ¦¦  $8.40  $8.40 ¦¦                                  ¦            ¦
   3 TO 4.5 KG (6 TO 9 LBS)    ¦   $8.80  $8.80 ¦¦  $8.80  $8.80 ¦¦G. TRANSPORT OF FEED AND FISH:    ¦            ¦
   OVER 4.5 KG (OVER 9 LBS)    ¦   $9.00  $9.00 ¦¦  $9.00  $9.00 ¦¦      of feed to farm     $30,661 ¦    $14,522 ¦   $45,183
     PRICE REDUCTION FOR SALES THAT OCCUR                        ¦¦      fish to proces.     $85,586 ¦    $44,084 ¦  $129,671
        DURING THE COMMERCIAL FISHING SEASON:          90%       ¦¦      pack.fish to Van    $31,122 ¦    $16,031 ¦   $47,153
                                                                 ¦¦      cost/kg of dress.           ¦            ¦
                                                                 ¦¦         fish produced      $0.57 ¦      $0.56 ¦     $0.56
```

VARIABLES AND STATISTICS continued

```
13.TRANSPORT COSTS:

                                PRICE/KG
          OF FEED TO FARM:        $0.05
     OF LIVE FISH TO PROC.:       $0.33
  OF PACKAGED FISH TO VAN.:       $0.12

   (For other charges see 'transport premiums' under the
    headings of 'operating costs' and 'capital purchases'.)

14.PEN AND NET REQUIREMENTS AND COSTS:
           PEN DIMENSIONS:          15 meters per side
                NET DEPTH:          12 meters
    MAX. LOADING DENSITY:          8.0 kg/cubic meter
        COST OF WALKWAYS:         $450 per meter of length

15.COST OF NETTING AND CONSTRUCTION:
            ave. fish weight  ¦ mesh    $/sq.m  const.factor
   * (Smolts) 0 TO .050 KG    ¦ 6MM     $3.25     1.60
             .050 TO .200 KG  ¦ 10MM    $1.80     1.75
             .200 TO .750 KG  ¦ 13MM    $1.75     1.50
               .750 AND OVER  ¦ 20MM    $1.60     1.40

   * Smolt nets are 1/2 the size of other nets.

16.LOAN TIMING AND INTEREST CHARGES:
          SHORT TERM DEBT: (5 years)  interest=   16.0%
                           ¦ YEAR ONE        ¦ YEAR TWO
                           ¦ 1st qtr       0 ¦ 1st qtr 300000
                           ¦ 2nd qtr       0 ¦ 2nd qtr 300000
                           ¦ 3rd qtr       0 ¦ 3rd qtr 300000
                           ¦ 4th qtr       0 ¦ 4th qtr      0

           LONG TERM DEBT: (10 yrs.)  interest=   16.0%
                           ¦ YEAR ONE        ¦ YEAR TWO
                           ¦ 1st qtr       0 ¦ 1st qtr      0
                           ¦ 2nd qtr       0 ¦ 2nd qtr      0
                           ¦ 3rd qtr       0 ¦ 3rd qtr      0
                           ¦ 4th qtr       0 ¦ 4th qtr 300000

17.FACTORS FOR 'COSTS OF GOODS SOLD':
                  SMOLTS:  chinook   $0.70 @ with delivery
                              coho   $0.60 @ with delivery
      MEDICINE AND VET.:       $10 /tonne managed @ month
                  WAGES:    $2,500 /month minimum plus
                            $2,200 /man/month
                              0.75  tonnes/day/man
                  FUELS:        $6 /tonne managed @ month
     TRANSPORT PREMIUM:         0% of above
```

```
                                 CHINOOK      COHO      COMBINED
¦¦                             ------------------------------------
¦¦H. REVENUES:                            ¦           ¦
¦¦      top-grade          $2,157,887 ¦  $844,546 ¦$3,002,434
¦¦      down-grade            $33,369 ¦   $32,647 ¦   $66,016
¦¦                   total $2,191,257 ¦  $877,193 ¦$3,068,449
¦¦      ave.price (Van.)        $8.45 ¦     $6.57 ¦     $7.81
¦¦      ave.farm-gate           $6.39 ¦     $4.57 ¦     $5.77
¦¦
¦¦I. PEAK INVENT. VALUE:$1,878,732 ¦  $737,931 ¦$2,616,663
¦¦                                    ¦           ¦
¦¦J. PEN REQUIREMENTS:                ¦           ¦
¦¦      size of square                ¦           ¦        15
¦¦      number required          14.0 ¦       6.0 ¦      20.0
¦¦      peak density              7.9 ¦       7.9 ¦
¦¦      total cost           $297,000 ¦  $135,000 ¦  $432,000
¦¦      ave. cost/pen         $21,214 ¦   $22,500 ¦   $21,600
¦¦                                    ¦           ¦
¦¦K. NET REQUIREMENTS:                ¦           ¦
¦¦      depth                         ¦           ¦        12
¦¦      cap. in kg/net                ¦           ¦     21600
¦¦      number nets req.         16.4 ¦      11.0 ¦      27.4
¦¦      total cost            $63,543 ¦   $43,607 ¦  $107,150
¦¦      average cost           $3,885 ¦    $3,964 ¦    $3,917
¦¦      * cost of 6mm                 ¦           ¦    $4,753
¦¦      cost of 10mm                  ¦           ¦    $4,678
¦¦      cost of 13mm                  ¦           ¦    $4,134
¦¦      cost of 20mm                  ¦           ¦    $3,629
¦¦
¦¦L. PEAK REQUIREMENTS:
¦¦                  Debt $1,192,500
¦¦                Equity $1,267,863
¦¦
¦¦M,N,O                          M.          N.            O.
¦¦                          % EQUITY ¦ REVENUES   ¦ PROFIT A/T
¦¦        END OF YEAR 1         100%¦         $0 ¦         $0
¦¦                YEAR 2         52%¦   $877,193 ¦         $0
¦¦                YEAR 3         60%¦$3,068,449 ¦   $365,742
¦¦                YEAR 4         70%¦$3,068,449 ¦   $451,737
¦¦                YEAR 5         86%¦$3,068,449 ¦   $506,506
¦¦                YEAR 6         88%¦$3,068,449 ¦   $306,198
¦¦                YEAR 7         90%¦$3,068,449 ¦   $286,685
¦¦                YEAR 8         92%¦$3,068,449 ¦   $285,562
¦¦
¦¦P. RETURN ON INVESTMENT:
¦¦     (Ten year I.R.R. on after tax profit.)        18.8%
¦¦
¦¦
¦¦
```

18.FACTORS FOR "FIXED COSTS":

MGMT SALARIES:	$6,000 /month minimum, or $1,000 /per month/50000 smolts
STOCK INSURANCE:	4.5% of peak mkt.value @ yr.
ASSET INSURANCE:	1.5% of asset value @ year
OFFICE AND TELEPHONE:	$10 /tonne managed @ month
LEGAL AND ACCOUNTING:	$30,000 for start-up $2 /tonne managed @ month
MAINTENANCE:	5% of one year old assets
MISCELLANEOUS:	20% of previous total

19.FACTORS FOR "CAPITAL PURCHASES":

ANCHORING:	$5,000 at start-up plus $1,500 /pen
FEED STORAGE:	$2,000 /tonne of requirement
ACCOMMODATIONS:	$17,000 /man required
DECKS AND DOCKS:	30% of feed storage costs
POWER SUPPLY:	$15,000 at start-up
FEEDERS:	$0 after one year or $0 /pen
BOATS AND TRUCK:	$40,000 for start-up $1 /tonne managed @ month
MISCELLANEOUS:	$100,000 start-up plus 15% of previous total
TRANSPORT PREMIUM:	0% of previous total
REPLACEMENTS:	10% of 3 year old assets

20.CAPITAL COST ALLOWANCE RATE: 25% one pool of all assets

21.TAX RATE: 46% of profit after losses have been carried forward

Q. COST OF PRODUCTION/KG OF PRODUCT SOLD (F.O.B. VANCOUVER)
(averaged over years 3, 4 and 5)

		$/kg	% of total
COST OF GOODS SOLD:	Total	$5.18	77.5%
		---------	---------
	Feed	$2.83	42.3%
	Processing	$0.95	14.3%
	Transports	$0.56	8.5%
OVERHEAD:	Total	$1.50	22.5%
		---------	---------
	Fixed costs	$0.77	11.5%
	Interest	$0.29	4.3%
	Deprec.	$0.45	6.7%
		---------	---------
TOTAL:		$6.69	

R. COST OF PRODUCTION AT THE FARM

	COMBINED

Farmgate (drsd)	$5.28
Farmgate (round)	$4.76
	-----------
farm sale price	$5.77
	=======
margin	$1.01

MONOSEX CHINOOK CHIN1 (of 4)

TIME			BIOMASS					MORTALITY				
1	2	3	4	5a	5b	6	7	8a	8b	9	10	11
mon.	qtr.	year	number remain. at end	real ave. weight	ave. weight used	growth (%)	biomass at end	real mortal. rate	mortal. rate used	number lost	biomass lost	% mortal. to date
Jan	1	one	0	0.000	0.000		0	0.0%	0.0%	0	0	0%
Feb	1	one	0	0.000	0.000		0	0.0%	0.0%	0	0	0%
Mar	1	one	0	0.000	0.000		0	0.0%	0.0%	0	0	0%
Apr	2	one	150000	0.007	0.007		1050	0.0%	0.0%	0	0	0%
May	2	one	142500	0.013	0.013	86%	1853	5.0%	5.0%	7500	98	5%
Jun	2	one	141075	0.025	0.025	92%	3527	1.0%	1.0%	1425	36	6%
Jul	3	one	139664	0.045	0.045	80%	6285	1.0%	1.0%	1411	63	7%
Aug	3	one	136871	0.075	0.075	67%	10265	2.0%	2.0%	2793	209	9%
Sep	3	one	135502	0.110	0.110	47%	14905	1.0%	1.0%	1369	151	10%
Oct	4	one	134825	0.160	0.160	45%	21572	0.5%	0.5%	678	108	10%
Nov	4	one	134151	0.210	0.210	31%	28172	0.5%	0.5%	674	142	11%
Dec	4	one	132809	0.270	0.270	29%	35858	1.0%	1.0%	1342	362	11%
Jan	1	two	131481	0.330	0.330	22%	43389	1.0%	1.0%	1328	438	12%
Feb	1	two	128851	0.380	0.380	15%	48964	2.0%	2.0%	2630	999	14%
Mar	1	two	126919	0.420	0.420	11%	53306	1.5%	1.5%	1933	812	15%
Apr	2	two	125649	0.470	0.470	12%	59055	1.0%	1.0%	1269	597	16%
May	2	two	124393	0.530	0.530	13%	65928	1.0%	1.0%	1256	666	17%
Jun	2	two	123149	0.640	0.640	21%	78815	1.0%	1.0%	1244	796	18%
Jul	3	two	120686	0.780	0.780	22%	94135	2.0%	2.0%	2463	1921	20%
Aug	3	two	118272	0.950	0.950	22%	112359	2.0%	2.0%	2414	2293	21%
Sep	3	two	117090	1.200	1.200	26%	140508	1.0%	1.0%	1183	1419	22%
Oct	4	two	115919	1.400	1.400	17%	162286	1.0%	1.0%	1171	1639	23%
Nov	4	two	113600	1.600	1.600	14%	181761	2.0%	2.0%	2318	3709	24%
Dec	4	two	111328	1.800	1.800	12%	200391	2.0%	2.0%	2272	4090	26%
Jan	1	three	109102	2.050	2.050	14%	223659	2.0%	2.0%	2227	4564	27%
Feb	1	three	85099	2.300	2.300	12%	195729	2.0%	2.0%	2182	5019	29%
Mar	1	three	61577	2.600	2.600	13%	160100	2.0%	2.0%	1702	4425	30%
Apr	2	three	38525	3.000	3.000	15%	115575	2.0%	2.0%	1232	3695	31%
May	2	three	16320	3.400	3.400	13%	55486	1.0%	1.0%	385	1310	31%
Jun	2	three	0	3.900	3.900	15%	0	1.0%	1.0%	0	0	31%
Jul	3	three	0	4.500	4.500	15%	0	1.0%	1.0%	0	0	31%
Aug	3	three	0	5.000	5.000	11%	0	1.0%	1.0%	0	0	31%
Sep	3	three	0	5.500	5.500	10%	0	1.0%	1.0%	0	0	31%
Oct	4	three	0	6.000	6.000	9%	0	5.0%	5.0%	0	0	31%
Nov	4	three	0	6.500	6.500	8%	0	10.0%	10.0%	0	0	31%
Dec	4	three	0	7.000	7.000	8%	0	10.0%	10.0%	0	0	31%
										=======	=======	
										46399	39561	

```
::MONOSEX CHINOOK                                                                          CHIN2 (of 4)  ::
::                                                                                                       ::
::TIME         ::FEED COSTS                                                  ::HARVESTING                ::
::-1---2----3--::--12A----12B------13-----14a----14b-----15------16--- ::--17-----18------19-----20a----20b--::
::mon.     year :: real   conver. overall actual  cost/  weight  month's ::number ave.   total  actual % down ::
::    qtr.     ::conver. ratio  conver. cost/  kilo   consum.  feed    :: sold  weight  round  % down grades ::
::             :: ratio  used   effic.  kilo   used            cost    ::              harvest grades  used  ::
::             ::                                                      ::                                    ::
::Jan   1 one  ::   0.0     0.0     ERR  $0.00  $0.00      0      $0 ::     0  0.000       0    3.0%   3.0%::
::Feb   1 one  ::   0.0     0.0     ERR  $0.00  $0.00      0      $0 ::     0  0.000       0    3.0%   3.0%::
::Mar   1 one  ::   0.0     0.0     ERR  $0.00  $0.00      0      $0 ::     0  0.000       0    3.0%   3.0%::
::Apr   2 one  ::   0.0     0.0    0.00  $0.00  $0.00      0      $0 ::     0  0.004       0    3.0%   3.0%::
::May   2 one  ::   1.2     1.2    0.58  $1.35  $1.35   1080  $1,458 ::     0  0.010       0    3.0%   3.0%::
::Jun   2 one  ::   1.2     1.2    0.89  $1.35  $1.35   2052  $2,770 ::     0  0.019       0    3.0%   3.0%::
::Jul   3 one  ::   1.3     1.3    1.08  $1.35  $1.35   3668  $4,952 ::     0  0.035       0    3.0%   3.0%::
::Aug   3 one  ::   1.3     1.3    1.19  $1.35  $1.35   5447  $7,353 ::     0  0.060       0    3.0%   3.0%::
::Sep   3 one  ::   1.4     1.4    1.27  $1.35  $1.35   6707  $9,054 ::     0  0.093       0    3.0%   3.0%::
::Oct   4 one  ::   1.4     1.4    1.32  $1.35  $1.35   9485 $12,805 ::     0  0.135       0    3.0%   3.0%::
::Nov   4 one  ::   1.4     1.4    1.34  $1.35  $1.35   9438 $12,741 ::     0  0.185       0    3.0%   3.0%::
::Dec   4 one  ::   1.5     1.5    1.39  $1.35  $1.35  12074 $16,299 ::     0  0.240       0    3.0%   3.0%::
::Jan   1 two  ::   1.5     1.5    1.43  $1.35  $1.35  11953 $16,136 ::     0  0.300       0    3.0%   3.0%::
::Feb   1 two  ::   1.5     1.5    1.47  $1.35  $1.35   9861 $13,312 ::     0  0.355       0    3.0%   3.0%::
::Mar   1 two  ::   1.6     1.6    1.50  $1.35  $1.35   8246 $11,133 ::     0  0.400       0    3.0%   3.0%::
::Apr   2 two  ::   1.6     1.6    1.53  $1.35  $1.35  10153 $13,707 ::     0  0.445       0    3.0%   3.0%::
::May   2 two  ::   1.7     1.7    1.56  $1.20  $1.20  12816 $15,379 ::     0  0.500       0    3.0%   3.0%::
::Jun   2 two  ::   1.7     1.7    1.60  $1.20  $1.20  23261 $27,914 ::     0  0.585       0    3.0%   3.0%::
::Jul   3 two  ::   1.7     1.7    1.65  $1.20  $1.20  29309 $35,171 ::     0  0.710       0    3.0%   3.0%::
::Aug   3 two  ::   1.7     1.7    1.69  $1.20  $1.20  34878 $41,854 ::     0  0.865       0    3.0%   3.0%::
::Sep   3 two  ::   1.8     1.8    1.73  $1.20  $1.20  53223 $63,867 ::     0  1.075       0    3.0%   3.0%::
::Oct   4 two  ::   1.8     1.8    1.76  $1.20  $1.20  42152 $50,583 ::     0  1.300       0    3.0%   3.0%::
::Nov   4 two  ::   1.8     1.8    1.80  $1.20  $1.20  41731 $50,077 ::     0  1.500       0    3.0%   3.0%::
::Dec   4 two  ::   1.8     1.8    1.84  $1.20  $1.20  40896 $49,075 ::     0  1.700       0    3.0%   3.0%::
::Jan   1 three::   1.9     1.9    1.88  $1.20  $1.20  52881 $63,457 ::     0  1.925       0    3.0%   3.0%::
::Feb   1 three::   1.9     1.9    1.95  $1.20  $1.20  51823 $62,188 :: 21820  2.175   47459    3.0%   3.0%::
::Mar   1 three::   1.9     1.9    2.00  $1.20  $1.20  48507 $58,208 :: 21820  2.450   53460    3.0%   3.0%::
::Apr   2 three::   1.9     1.9    2.05  $1.20  $1.20  46799 $56,158 :: 21820  2.800   61097    3.0%   3.0%::
::May   2 three::   1.9     1.9    2.08  $1.20  $1.20  29279 $35,135 :: 21820  3.200   69825    3.0%   3.0%::
::Jun   2 three::   1.9     1.9    2.10  $1.20  $1.20  15504 $18,604 :: 16320  3.650   59566    3.0%   3.0%::
::Jul   3 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  4.200       0    3.0%   3.0%::
::Aug   3 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  4.750       0    3.0%   3.0%::
::Sep   3 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  5.250       0    3.0%   3.0%::
::Oct   4 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  5.750       0    3.0%   3.0%::
::Nov   4 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  6.250       0    3.0%   3.0%::
::Dec   4 three::   1.9     1.9    2.10  $1.20  $1.20      0      $0 ::     0  6.750       0    3.0%   3.0%::
::             ::                                    ======= ======= :: ======        =======              ::
::             ::                            ------- 613223 $749,392 ::103601 ------- 291400               ::
::             ::                  weighted ave. $1.22                 ::        2.813                       ::
::             ::                                                      ::                                    ::
```

MONOSEX CHINOOK

CHIN3 (of 4)

TIME			PROCESSING LOSSES AND COSTS						REVENUES AND INVENTORY VALUE				
1 mon.	2 qtr.	3 year	21 weight reduc.	22 total dressed weight	23 bleeding costs	24 gutting costs	25 packag. costs	26 total process. costs	27 top-grade price	28 revenue from top-grade	29 down-grade price	30 revenue from down-grades	31 market value of inventory
Jan	1	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$0
Feb	1	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$0
Mar	1	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$0
Apr	2	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$0
May	2	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$5,775
Jun	2	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$10,189
Jul	3	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$19,398
Aug	3	one	11.0%	0	$0	$0	$0	$0	$4.95	$0	$2.48	$0	$31,110
Sep	3	one	11.0%	0	$0	$0	$0	$0	$4.95	$0	$2.48	$0	$50,813
Oct	4	one	11.0%	0	$0	$0	$0	$0	$4.95	$0	$2.48	$0	$73,781
Nov	4	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$118,646
Dec	4	one	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$154,944
Jan	1	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$197,222
Feb	1	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$238,638
Mar	1	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$269,299
Apr	2	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$293,182
May	2	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$324,804
Jun	2	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$362,605
Jul	3	two	11.0%	0	$0	$0	$0	$0	$5.50	$0	$2.75	$0	$433,485
Aug	3	two	11.0%	0	$0	$0	$0	$0	$4.95	$0	$2.48	$0	$465,969
Sep	3	two	11.0%	0	$0	$0	$0	$0	$4.95	$0	$2.48	$0	$556,176
Oct	4	two	11.0%	0	$0	$0	$0	$0	$5.94	$0	$2.97	$0	$834,615
Nov	4	two	11.0%	0	$0	$0	$0	$0	$6.60	$0	$3.30	$0	$1,071,089
Dec	4	two	11.0%	0	$0	$0	$0	$0	$6.60	$0	$3.30	$0	$1,199,619
Jan	1	three	11.0%	0	$0	$0	$0	$0	$6.60	$0	$3.30	$0	$1,322,580
Feb	1	three	11.0%	42239	$9,293	$23,231	$11,404	$43,928	$6.60	$0	$3.30	$0	$1,878,732
Mar	1	three	11.0%	47579	$10,467	$26,169	$12,846	$49,482	$8.40	$344,161	$4.20	$5,322	$1,644,120
Apr	2	three	11.0%	54376	$10,875	$21,751	$13,050	$45,676	$8.40	$387,676	$4.20	$5,995	$1,344,842
May	2	three	11.0%	62144	$12,429	$24,858	$14,915	$52,201	$8.40	$443,058	$4.20	$6,851	$1,017,064
Jun	2	three	11.0%	53014	$10,603	$21,206	$12,723	$44,532	$8.80	$530,464	$4.40	$8,203	$488,281
Jul	3	three	11.0%	0	$0	$0	$0	$0	$8.80	$452,528	$4.40	$6,998	$0
Aug	3	three	11.0%	0	$0	$0	$0	$0	$7.92	$0	$3.96	$0	$0
Sep	3	three	11.0%	0	$0	$0	$0	$0	$8.10	$0	$4.05	$0	$0
Oct	4	three	11.0%	0	$0	$0	$0	$0	$8.10	$0	$4.05	$0	$0
Nov	4	three	11.0%	0	$0	$0	$0	$0	$9.00	$0	$4.50	$0	$0
Dec	4	three	11.0%	0	$0	$0	$0	$0	$9.00	$0	$4.50	$0	$0
				=======				========		=========		========	
				259353				$235,820		$2,157,887		$33,369	---------
						proc. costs/kg =		$0.91					$1,878,732

```
::MONOSEI CHINOOK                                                              CHIN4 (of 4)   ::
::                                                                                            ::
::TIME         ::PEN REQUIREMENTS AND COSTS                ::NET REQUIREMENTS AND COSTS       ::
::-1---2----3--::-32---33---34---35----36-----37-----38----::--39----40----41----42-----43----::
::mon.    year :: 1st  2nd  3rd  no.  no. minimum     pen  ::-- first cycle nets ---    net   ::
::    qtr.     ::year year year pens pens biomass  purch-  ::  6mm  10mm  13mm  20mm purchases::
::             ::pens pens pens req. in   density    ases  :: nets  nets  nets  nets          ::
::             ::                    use (kg/cu.m)         ::                                 ::
::Jan   1 one  :: 0.0            0.0   0.0    ERR      $0  ::  0.0                         $0 ::
::Feb   1 one  :: 0.0            0.0   0.0    ERR      $0  ::  0.0                         $0 ::
::Mar   1 one  :: 0.0            0.0   0.0    ERR      $0  ::  1.0   0.0               $4,753 ::
::Apr   2 one  :: 0.0            0.0   2.0    0.2 $54,000  ::  1.0   0.0                   $0 ::
::May   2 one  :: 0.1            0.1   2.0    0.3      $0  ::  1.0   0.0   0.0             $0 ::
::Jun   2 one  :: 0.2            0.2   2.0    0.7      $0  ::  1.0   0.0   0.0             $0 ::
::Jul   3 one  :: 0.3            0.3   2.0    1.2      $0  ::  1.0   0.0   0.0   0.0       $0 ::
::Aug   3 one  :: 0.5            0.5   2.0    1.9      $0  ::  0.0   1.0   0.0   0.0   $4,678 ::
::Sep   3 one  :: 0.7            0.7   2.0    2.8      $0  ::  0.0   1.0   0.0   0.0       $0 ::
::Oct   4 one  :: 1.0            1.0   2.0    4.0      $0  ::  0.0   1.0   0.0   0.0       $0 ::
::Nov   4 one  :: 1.3            1.3   2.0    5.2      $0  ::  0.0   0.0   2.0   0.0   $8,269 ::
::Dec   4 one  :: 1.7            1.7   2.0    6.6      $0  ::  0.0   0.0   2.0   0.0       $0 ::
::Jan   1 two  :: 2.0  0.0       2.0   4.0    4.0 $40,500  ::        0.0   3.0   0.0   $4,134 ::
::Feb   1 two  :: 2.3  0.0       2.3   4.0    4.5      $0  ::        0.0   3.0   0.0       $0 ::
::Mar   1 two  :: 2.5  0.0       2.5   4.0    4.9      $0  ::        0.0   3.0   0.0       $0 ::
::Apr   2 two  :: 2.7  0.0       2.8   4.0    5.6      $0  ::        0.0   3.0   0.0       $0 ::
::May   2 two  :: 3.1  0.1       3.1   4.0    6.3      $0  ::        0.0   4.0   0.0   $4,134 ::
::Jun   2 two  :: 3.6  0.2       3.8   4.0    7.6      $0  ::        0.0   4.0   0.0       $0 ::
::Jul   3 two  :: 4.4  0.3       4.6   6.0    6.2 $40,500  ::        0.0   0.0   5.0  $18,144 ::
::Aug   3 two  :: 5.2  0.5       5.7   6.0    7.6      $0  ::        0.0   0.0   6.0   $3,629 ::
::Sep   3 two  :: 6.5  0.7       7.2   8.0    7.2 $40,500  ::              0.0   7.0   $3,629 ::
::Oct   4 two  :: 7.5  1.0       8.5  10.0    6.8 $40,500  ::              0.0  10.0  $10,886 ::
::Nov   4 two  :: 8.4  1.3       9.7  10.0    7.8      $0  ::              0.0  10.0       $0 ::
::Dec   4 two  :: 9.3  1.7      10.9  12.0    7.3 $40,500  ::              0.0  10.0       $0 ::
::Jan   1 three::10.4  2.0  0.0 12.4  14.0    7.1 $40,500  ::              0.0  10.4   $1,287 ::
::Feb   1 three:: 9.1  2.3  0.0 11.3  12.0    7.6      $0  ::              0.0  10.0       $0 ::
::Mar   1 three:: 7.4  2.5  0.0  9.9  10.0    7.9      $0  ::              0.0  10.0       $0 ::
::Apr   2 three:: 5.4  2.7  0.0  8.1  10.0    6.5      $0  ::              0.0   6.0       $0 ::
::May   2 three:: 2.6  3.1  0.1  5.7   6.0    7.6      $0  ::                    0.0       $0 ::
::Jun   2 three:: 0.0  3.6  0.2  3.8   4.0    7.6      $0  ::                    0.0       $0 ::
::Jul   3 three:: 0.0  4.4  0.3  4.6   6.0    6.2      $0  ::                    0.0       $0 ::
::Aug   3 three:: 0.0  5.2  0.5  5.7   6.0    7.6      $0  ::                    0.0       $0 ::
::Sep   3 three:: 0.0  6.5  0.7  7.2   8.0    7.2      $0  ::                    0.0       $0 ::
::Oct   4 three:: 0.0  7.5  1.0  8.5  10.0    6.8      $0  ::                    0.0       $0 ::
::Nov   4 three:: 0.0  8.4  1.3  9.7  10.0    7.8      $0  ::                    0.0       $0 ::
::Dec   4 three:: 0.0  9.3  1.7 10.9  12.0    7.3      $0  ::                    0.0       $0 ::
::             ::                                  ========::                        ======== ::
::             ::                    -----  ---- $297,000  ::  total no. nets = 16.4  $63,543 ::
::             ::               max = 14.0    7.9          ::                                 ::
::             ::                                          ::                                 ::
```

```
::SO COHO                                                                  COHO1 (of 4)   ::
::                                                                                        ::
::TIME         ::BIOMASS                                 ::MORTALITY                      ::
::-1---2----3--::---4------5a-----5b------6------7--- ::--8a-----8b------9-------10------11----::
::mon.    year ::number   real   ave.  growth  biomass:: real  mortal. number biomass % mortal.::
::    qtr.     ::remain.  ave.  weight  (%)    at end ::mortal. rate    lost    lost   to date ::
::             ::at end  weight  used                 :: rate   used                           ::
::             ::                                     ::                                       ::
::Jan   1 one  ::      0  0.000  0.000     0%       0 ::  0.0%   0.0%       0       0        0%::
::Feb   1 one  ::      0  0.000  0.000    ERR       0 ::  0.0%   0.0%       0       0        0%::
::Mar   1 one  ::      0  0.000  0.000    ERR       0 ::  0.0%   0.0%       0       0        0%::
::Apr   2 one  ::      0  0.000  0.000    ERR       0 ::  0.0%   0.0%       0       0        0%::
::May   2 one  ::      0  0.000  0.000    ERR       0 ::  0.0%   0.0%       0       0        0%::
::Jun   2 one  :: 100000  0.020  0.020    ERR    2000 ::  0.0%   0.0%       0       0        0%::
::Jul   3 one  ::  85000  0.040  0.040   100%    3400 :: 15.0%  15.0%   15000     600       15%::
::Aug   3 one  ::  83300  0.075  0.075    88%    6248 ::  2.0%   2.0%    1700     128       17%::
::Sep   3 one  ::  82467  0.130  0.130    73%   10721 ::  1.0%   1.0%     833     108       18%::
::Oct   4 one  ::  81642  0.180  0.180    38%   14696 ::  1.0%   1.0%     825     148       18%::
::Nov   4 one  ::  81234  0.230  0.230    28%   18684 ::  0.5%   0.5%     408      94       19%::
::Dec   4 one  ::  80828  0.290  0.290    26%   23440 ::  0.5%   0.5%     406     118       19%::
::Jan   1 two  ::  80020  0.360  0.360    24%   28807 ::  1.0%   1.0%     808     291       20%::
::Feb   1 two  ::  78419  0.460  0.460    28%   36073 ::  2.0%   2.0%    1600     736       22%::
::Mar   1 two  ::  77635  0.600  0.600    30%   46581 ::  1.0%   1.0%     784     471       22%::
::Apr   2 two  ::  76859  0.800  0.800    33%   61487 ::  1.0%   1.0%     776     621       23%::
::May   2 two  ::  76090  1.050  1.050    31%   79895 ::  1.0%   1.0%     769     807       24%::
::Jun   2 two  ::  74568  1.350  1.350    29%  100667 ::  2.0%   2.0%    1522    2054       25%::
::Jul   3 two  ::  73077  1.700  1.700    26%  124231 ::  2.0%   2.0%    1491    2535       27%::
::Aug   3 two  ::  35077  2.100  2.100    24%   73662 ::  2.0%   2.0%    1462    3069       28%::
::Sep   3 two  ::      0  2.500  2.500    19%       0 ::  2.0%   2.0%       0       0       28%::
::Oct   4 two  ::      0  2.700  2.700     8%       0 ::  5.0%   5.0%       0       0       28%::
::Nov   4 two  ::      0  2.800  2.800     4%       0 :: 10.0%  10.0%       0       0       28%::
::Dec   4 two  ::      0  2.800  2.800     0%       0 :: 20.0%  20.0%       0       0       28%::
::Jan   1 three::      0  2.800  2.800     0%       0 :: 30.0%  30.0%       0       0       28%::
::Feb   1 three::      0  2.800  2.800     0%       0 :: 20.0%  20.0%       0       0       28%::
::Mar   1 three::      0  2.800  2.800     0%       0 :: 10.0%  10.0%       0       0       28%::
::Apr   2 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::May   2 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Jun   2 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Jul   3 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Aug   3 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Sep   3 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Oct   4 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Nov   4 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::Dec   4 three::      0  2.800  2.800     0%       0 ::  0.0%   0.0%       0       0       28%::
::             ::                                     ::              ======= =======          ::
::             ::                                     ::                28305   11781          ::
::             ::                                     ::                                       ::
::             ::                                     ::                                       ::
```

```
::SO COHO                                                                                    COHO2 (of 4)  ::
::                                                                                                         ::
::TIME          ::FEED COSTS                                                ::HARVESTING                   ::
::-1---2----3--::--12A----12B------13-----14a----14b-----15------16--- ::--17-----18------19-----20a----20b--::
::mon.     year :: real  conver. overall actual  cost/  weight  month's ::number ave.    total  actual % down ::
::    qtr.      ::conver. ratio  conver. cost/   kilo   consum.  feed   :: sold  weight  round  % down grades ::
::              :: ratio  used   effic.  kilo    used            cost   ::               harvest grades  used ::
::              ::                                                      ::                                   ::
::Jan   1 one  ::   0.0     0.0      ERR $0.00  $0.00       0       $0 ::      0 0.000        0    3.0%   3.0%::
::Feb   1 one  ::   0.0     0.0      ERR $0.00  $0.00       0       $0 ::      0 0.000        0    3.0%   3.0%::
::Mar   1 one  ::   0.0     0.0      ERR $0.00  $0.00       0       $0 ::      0 0.000        0    3.0%   3.0%::
::Apr   2 one  ::   0.0     0.0      ERR $0.00  $0.00       0       $0 ::      0 0.000        0    3.0%   3.0%::
::May   2 one  ::   0.0     0.0      ERR $0.00  $0.00       0       $0 ::      0 0.000        0    3.0%   3.0%::
::Jun   2 one  ::   0.0     0.0     0.00 $0.00  $0.00       0       $0 ::      0 0.010        0    3.0%   3.0%::
::Jul   3 one  ::   1.2     1.2     0.71 $1.35  $1.35    2400   $3,240 ::      0 0.030        0    3.0%   3.0%::
::Aug   3 one  ::   1.2     1.2     0.96 $1.35  $1.35    3570   $4,820 ::      0 0.058        0    3.0%   3.0%::
::Sep   3 one  ::   1.3     1.3     1.11 $1.35  $1.35    5956   $8,041 ::      0 0.103        0    3.0%   3.0%::
::Oct   4 one  ::   1.3     1.3     1.18 $1.35  $1.35    5360   $7,236 ::      0 0.155        0    3.0%   3.0%::
::Nov   4 one  ::   1.4     1.4     1.23 $1.35  $1.35    5715   $7,715 ::      0 0.205        0    3.0%   3.0%::
::Dec   4 one  ::   1.4     1.4     1.27 $1.35  $1.35    6824   $9,212 ::      0 0.260        0    3.0%   3.0%::
::Jan   1 two  ::   1.5     1.5     1.33 $1.35  $1.35    8487  $11,457 ::      0 0.325        0    3.0%   3.0%::
::Feb   1 two  ::   1.5     1.5     1.39 $1.35  $1.35   12003  $16,204 ::      0 0.410        0    3.0%   3.0%::
::Mar   1 two  ::   1.6     1.6     1.46 $1.35  $1.35   17566  $23,714 ::      0 0.530        0    3.0%   3.0%::
::Apr   2 two  ::   1.6     1.6     1.51 $1.35  $1.35   24843  $33,538 ::      0 0.700        0    3.0%   3.0%::
::May   2 two  ::   1.7     1.7     1.57 $1.20  $1.20   32665  $39,198 ::      0 0.925        0    3.0%   3.0%::
::Jun   2 two  ::   1.7     1.7     1.63 $1.20  $1.20   38806  $46,567 ::      0 1.200        0    3.0%   3.0%::
::Jul   3 two  ::   1.8     1.8     1.70 $1.20  $1.20   46978  $56,374 ::      0 1.525        0    3.0%   3.0%::
::Aug   3 two  ::   1.8     1.8     1.84 $1.20  $1.20   52615  $63,139 :: 36538 1.900    69423    3.0%   3.0%::
::Sep   3 two  ::   1.9     1.9     1.94 $1.20  $1.20   26658  $31,990 :: 35077 2.300    80677   10.0%  10.0%::
::Oct   4 two  ::   2.0     2.0     1.94 $1.20  $1.20       0       $0 ::      0 2.600        0   20.0%  20.0%::
::Nov   4 two  ::   2.0     2.0     1.94 $1.20  $1.20       0       $0 ::      0 2.750        0   50.0%  50.0%::
::Dec   4 two  ::   2.0     2.0     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Jan   1 three::   1.9     1.9     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Feb   1 three::   1.8     1.8     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Mar   1 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Apr   2 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::May   2 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Jun   2 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Jul   3 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Aug   3 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Sep   3 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Oct   4 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Nov   4 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::Dec   4 three::   1.7     1.7     1.94 $1.20  $1.20       0       $0 ::      0 2.800        0  100.0% 100.0%::
::             ::                                   ======= ======= :: ======        =======              ::
::             ::                           ------- 290447 $362,445 :: 71615 ------- 150100               ::
::             ::                 weighted ave. $1.25                ::       2.096                        ::
::             ::                                                    ::                                    ::
```

```
::SO COHO
::                                                                                          COHO3 (of4)  ::
::TIME         ::PROCESSING LOSSES AND COSTS                              ::REVENUES AND INVENTORY VALUE   ::
::-1---2----3--::--21------22------23-------24------25------26----::--27------28-------29-------30-------31-----::
::mon.     year ::weight  total  bleeding gutting packag.  total   ::top-   revenue   down-   revenue   market  ::
::    qtr.      ::reduc. dressed  costs    costs   costs  process. ::grade   from     grade    from    value of ::
::              ::        weight                           costs   ::price   top-     price    down-   inventory::
::              ::                                                 ::        grade             grades           ::
::Jan   1 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0        $0 ::
::Feb   1 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0        $0 ::
::Mar   1 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0        $0 ::
::Apr   2 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0        $0 ::
::May   2 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0        $0 ::
::Jun   2 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0   $11,000 ::
::Jul   3 one   ::  11.0%      0       $0       $0      $0      $0 ::$4.95       $0   $2.48       $0   $16,830 ::
::Aug   3 one   ::  11.0%      0       $0       $0      $0      $0 ::$4.95       $0   $2.48       $0   $30,925 ::
::Sep   3 one   ::  11.0%      0       $0       $0      $0      $0 ::$4.95       $0   $2.48       $0   $53,068 ::
::Oct   4 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0   $80,826 ::
::Nov   4 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $102,761 ::
::Dec   4 one   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $128,921 ::
::Jan   1 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $158,439 ::
::Feb   1 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $198,401 ::
::Mar   1 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $256,196 ::
::Apr   2 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $338,178 ::
::May   2 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.50       $0   $2.75       $0  $527,305 ::
::Jun   2 two   ::  11.0%      0       $0       $0      $0      $0 ::$6.60       $0   $3.30       $0  $664,404 ::
::Jul   3 two   ::  11.0%      0       $0       $0      $0      $0 ::$5.94       $0   $2.97       $0  $737,931 ::
::Aug   3 two   ::  11.0%  61787  $13,593  $33,983 $16,682 $64,258 ::$5.94 $356,002   $2.97   $5,505  $556,882 ::
::Sep   3 two   ::  11.0%  71803  $15,797  $39,491 $19,387 $74,675 ::$7.56 $488,544   $3.78  $27,141        $0 ::
::Oct   4 two   ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Nov   4 two   ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Dec   4 two   ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Jan   1 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Feb   1 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Mar   1 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Apr   2 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::May   2 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Jun   2 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Jul   3 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Aug   3 three ::  11.0%      0       $0       $0      $0      $0 ::$7.56       $0   $3.78       $0        $0 ::
::Sep   3 three ::  11.0%      0       $0       $0      $0      $0 ::$7.56       $0   $3.78       $0        $0 ::
::Oct   4 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Nov   4 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::Dec   4 three ::  11.0%      0       $0       $0      $0      $0 ::$8.40       $0   $4.20       $0        $0 ::
::              ::       =======                          ======== ::     =========          ========           ::
::              ::        133589                          $138,933 ::     $844,546           $32,647  --------- ::
::              ::                      proc. costs/kg =     $1.04 ::                                 $737,931 ::
::              ::                                                 ::                                           ::
```

10

```
::90 COHO                                                                      COHO4 (of 4)   ::
::                                                                                            ::
::TIME         ::PEN REQUIREMENTS AND COSTS                 ::NET REQUIREMENTS AND COSTS        ::
::-1---2----3--::-32---33---34---35----36-----37-----38----::--39----40----41----42-----43----::
::mon.     year:: 1st  2nd  3rd  no.  no.  minimum   pen   ::-- first cycle nets ---     net  ::
::    qtr.     ::year year year pens pens biomass  purch-  :: 6mm   10mm  13mm  20mm purchases::
::             ::pens pens pens req. in    density    ases  :: nets  nets  nets  nets          ::
::             ::                    use (kg/cu.m)          ::                                 ::
::Jan   1 one  :: 0.0            0.0  0.0      ERR      $0 ::  0.0                         $0 ::
::Feb   1 one  :: 0.0            0.0  0.0      ERR      $0 ::  0.0                         $0 ::
::Mar   1 one  :: 0.0            0.0  0.0      ERR      $0 ::  0.0   0.0                   $0 ::
::Apr   2 one  :: 0.0            0.0  0.0      ERR      $0 ::  0.0   0.0                   $0 ::
::May   2 one  :: 0.0            0.0  0.0      ERR      $0 ::  1.0   0.0   0.0         $4,753 ::
::Jun   2 one  :: 0.1            0.1  2.0      0.4 $54,000 ::  1.0   0.0   0.0             $0 ::
::Jul   3 one  :: 0.2            0.2  2.0      0.6      $0 ::  1.0   0.0   0.0   0.0       $0 ::
::Aug   3 one  :: 0.3            0.3  2.0      1.2      $0 ::  0.0   1.0   0.0   0.0   $4,678 ::
::Sep   3 one  :: 0.5            0.5  2.0      2.0      $0 ::  0.0   1.0   0.0   0.0       $0 ::
::Oct   4 one  :: 0.7            0.7  2.0      2.7      $0 ::  0.0   1.0   0.0   0.0       $0 ::
::Nov   4 one  :: 0.9            0.9  2.0      3.5      $0 ::  0.0   0.0   1.0   0.0   $4,134 ::
::Dec   4 one  :: 1.1            1.1  2.0      4.3      $0 ::  0.0   0.0   2.0   0.0   $4,134 ::
::Jan   1 two  :: 1.3  0.0       1.3  2.0      5.3      $0 ::        0.0   2.0   0.0       $0 ::
::Feb   1 two  :: 1.7  0.0       1.7  2.0      6.7      $0 ::        0.0   2.0   0.0       $0 ::
::Mar   1 two  :: 2.2  0.0       2.2  4.0      4.3 $40,500 ::        0.0   3.0   0.0   $4,134 ::
::Apr   2 two  :: 2.8  0.0       2.8  4.0      5.7      $0 ::        0.0   0.0   3.0  $10,886 ::
::May   2 two  :: 3.7  0.0       3.7  4.0      7.4      $0 ::        0.0   0.0   4.0   $3,629 ::
::Jun   2 two  :: 4.7  0.1       4.8  6.0      6.3 $40,500 ::        0.0   0.0   5.0   $3,629 ::
::Jul   3 two  :: 5.8  0.2       5.9  6.0      7.9      $0 ::        0.0   0.0   6.0   $3,629 ::
::Aug   3 two  :: 3.4  0.3       3.7  4.0      7.4      $0 ::        0.0   0.0   0.0       $0 ::
::Sep   3 two  :: 0.0  0.5       0.5  2.0      2.0      $0 ::              0.0   0.0       $0 ::
::Oct   4 two  :: 0.0  0.7       0.7  2.0      2.7      $0 ::              0.0   0.0       $0 ::
::Nov   4 two  :: 0.0  0.9       0.9  2.0      3.5      $0 ::              0.0   0.0       $0 ::
::Dec   4 two  :: 0.0  1.1       1.1  2.0      4.3      $0 ::              0.0   0.0       $0 ::
::Jan   1 three:: 0.0  1.3  0.0  1.3  2.0      5.3      $0 ::              0.0   0.0       $0 ::
::Feb   1 three:: 0.0  1.7  0.0  1.7  2.0      6.7      $0 ::              0.0   0.0       $0 ::
::Mar   1 three:: 0.0  2.2  0.0  2.2  4.0      4.3      $0 ::              0.0   0.0       $0 ::
::Apr   2 three:: 0.0  2.8  0.0  2.8  4.0      5.7      $0 ::              0.0   0.0       $0 ::
::May   2 three:: 0.0  3.7  0.0  3.7  4.0      7.4      $0 ::                    0.0       $0 ::
::Jun   2 three:: 0.0  4.7  0.1  4.8  6.0      6.3      $0 ::                    0.0       $0 ::
::Jul   3 three:: 0.0  5.8  0.2  5.9  6.0      7.9      $0 ::                    0.0       $0 ::
::Aug   3 three:: 0.0  3.4  0.3  3.7  4.0      7.4      $0 ::                    0.0       $0 ::
::Sep   3 three:: 0.0  0.0  0.5  0.5  2.0      2.0      $0 ::                    0.0       $0 ::
::Oct   4 three:: 0.0  0.0  0.7  0.7  2.0      2.7      $0 ::                    0.0       $0 ::
::Nov   4 three:: 0.0  0.0  0.9  0.9  2.0      3.5      $0 ::                    0.0       $0 ::
::Dec   4 three:: 0.0  0.0  1.1  1.1  2.0      4.3      $0 ::                    0.0       $0 ::
::             ::                                  ========::                         ======== ::
::             ::                   -----     ----$135,000 ::  total no. nets = 11.0  $43,607 ::
::             ::              max =  6.0      7.9          ::                                 ::
::             ::                                          ::                                 ::
```

STANDARD FARM MODEL

SOURCES-1A

SOURCES AND USES OF FUNDS (all dollar values x 1000)

YEAR	ONE				TOTAL	TWO				TOTAL	THREE				TOTAL
QUARTER	1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH	
PRODUCTION (in kg):	0	0	0	0	0	0	0	134	0	134	90	170	134	0	393
	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####
SOURCES OF FUNDS:															
REVENUES:															
Top-grade sales	0	0	0	0	0	0	0	845	0	845	732	1426	845	0	3002
Down-grade sales	0	0	0	0	0	0	0	33	0	33	11	22	33	0	66
LOANS:															
Short term	0	0	0	0	0	300	300	300	0	900					
Long term	0	0	0	0	0	0	0	0	300	300					
TOTALS	0	0	0	0	0	300	300	1177	300	2077	743	1448	877	0	3068
USES OF FUNDS:															
COST OF GOODS SOLD:															
Smolts		165			165		165			165		165			165
Feed	0	4	37	66	108	92	101	330	216	818	276	290	330	216	1112
Medicine and vet.	0	0	1	1	2	3	5	6	7	20	8	6	6	7	27
Feed transport	0	0	1	2	4	3	7	14	9	33	11	12	14	9	45
Wages	8	8	10	12	38	14	22	34	24	94	29	31	34	24	118
Fuels	0	0	0	1	1	2	3	4	4	12	5	4	4	4	16
Fish transports x2	0	0	0	0	0	0	0	60	0	60	40	76	60	0	177
Process. and packag.	0	0	0	0	0	0	0	139	0	139	93	142	139	0	375
Transport premium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	8	177	50	83	318	114	382	586	260	1341	463	727	586	260	2036
FIXED COSTS:															
Mgmt. salaries	18	18	18	18	72	18	18	18	18	72	18	18	18	18	72
Stock insurance	0	0	1	4	5	6	13	14	19	52	26	19	14	19	77
Asset insurance	1	2	2	2	6	2	3	3	4	12	3	3	3	3	12
Office + telephone	0	0	1	1	2	3	5	6	7	20	8	6	6	7	27
Legal and account.	30	0	0	0	30	1	1	1	1	4	2	1	1	1	5
Maintenance						9	10	11	13	43	13	13	13	13	54
Miscellaneous	10	4	4	5	23	8	10	11	12	40	14	12	11	12	50
TOTALS	58	24	27	31	140	46	58	64	73	242	84	73	67	74	298

'2

SOURCES-1B (of 2)

```
¦¦ FOUR  ¦¦ FIVE  ¦¦ SIX   ¦¦ SEVEN ¦¦ EIGHT ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦   393 ¦¦   393 ¦¦   393 ¦¦   393 ¦¦   393 ¦¦
¦¦ ***** ¦¦ ***** ¦¦ ***** ¦¦ ***** ¦¦ ***** ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦  3002 ¦¦  3002 ¦¦  3002 ¦¦  3002 ¦¦  3002 ¦¦
¦¦    66 ¦¦    66 ¦¦    66 ¦¦    66 ¦¦    66 ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦
¦¦  3068 ¦¦  3068 ¦¦  3068 ¦¦  3068 ¦¦  3068 ¦¦
¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦   165 ¦¦   165 ¦¦   165 ¦¦   165 ¦¦   165 ¦¦
¦¦  1112 ¦¦  1112 ¦¦  1112 ¦¦  1112 ¦¦  1112 ¦¦
¦¦    27 ¦¦    27 ¦¦    27 ¦¦    27 ¦¦    27 ¦¦
¦¦    45 ¦¦    45 ¦¦    45 ¦¦    45 ¦¦    45 ¦¦
¦¦   118 ¦¦   118 ¦¦   118 ¦¦   118 ¦¦   118 ¦¦
¦¦    16 ¦¦    16 ¦¦    16 ¦¦    16 ¦¦    16 ¦¦
¦¦   177 ¦¦   177 ¦¦   177 ¦¦   177 ¦¦   177 ¦¦
¦¦   375 ¦¦   375 ¦¦   375 ¦¦   375 ¦¦   375 ¦¦
¦¦     0 ¦¦     0 ¦¦     0 ¦¦     0 ¦¦     0 ¦¦
¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦
¦¦  2036 ¦¦  2036 ¦¦  2036 ¦¦  2036 ¦¦  2036 ¦¦
¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦
¦¦       ¦¦       ¦¦       ¦¦       ¦¦       ¦¦
¦¦    72 ¦¦    72 ¦¦    72 ¦¦    72 ¦¦    72 ¦¦
¦¦    77 ¦¦    77 ¦¦    77 ¦¦    77 ¦¦    77 ¦¦
¦¦     8 ¦¦     8 ¦¦     8 ¦¦     8 ¦¦     8 ¦¦
¦¦    27 ¦¦    27 ¦¦    27 ¦¦    27 ¦¦    27 ¦¦
¦¦     5 ¦¦     5 ¦¦     5 ¦¦     5 ¦¦     5 ¦¦
¦¦    59 ¦¦    67 ¦¦    74 ¦¦    82 ¦¦    89 ¦¦
¦¦    50 ¦¦    50 ¦¦    50 ¦¦    50 ¦¦    50 ¦¦
¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦ ===== ¦¦
¦¦   300 ¦¦   307 ¦¦   314 ¦¦   322 ¦¦   329 ¦¦
¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦ ----- ¦¦
```

SOURCES AND USES OF FUNDS continued... (all dollar values x 1000)

SOURCES-2A

YEAR	ONE				TOTAL	TWO				TOTAL	THREE				TOTAL
QUARTER	1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH	
CAPITAL PURCHASES:															
Pens	0	108	0	0	108	81	41	81	81	284	41	0	0	0	41
Nets	5	5	9	17	35	8	22	29	11	70	1	0	0	0	1
Anchoring	5	8	0	0	13	6	3	6	6	20	3	0	0	0	3
Feed storage			106		106					0					
Accommodations		76			76					0					
Decks and docks			32		32					0					
Power supply		15			15					0					
Feeders	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boats and truck	40	0	0	0	40	0	0	1	1	2	1	1	1	1	3
Misc. and farm equip	107	32	22	3	164	14	10	17	15	56	7	0	0	0	7
Transport premium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REPLACEMENTS															
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTALS	157	243	170	19	590	109	76	134	113	432	52	1	1	1	54
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
INTEREST CHARGES AND PRINCIPAL REPAYMENTS:															
SHORT TERM DEBT:															
Interest	0	0	0	0	0	12	24	36	36	108	36	33	30	27	126
Principal	0	0	0	0	0	0	0	0	0	0	75	75	75	75	300
LONG TERM DEBT:															
Interest	0	0	0	0	0	0	0	0	12	12	12	11	11	11	45
Principal	0	0	0	0	0	0	0	0	8	8	8	8	8	8	30
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTALS	0	0	0	0	0	12	24	36	56	128	130	127	124	120	501
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
TAXES:					0					0					0
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
REQUIREMENT FOR PERIOD:	223	444	246	133	1047	-19	240	-357	202	66	-13	-521	-100	455	-179
ACCUMULATED REQUIREMENT:	223	667	914	1047	1047	1028	1268	911	1112	1112	1099	578	478	933	933
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
EQUITY REQUIRED:	1268														
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

SOURCES-2B (of 2)

```
:: FOUR  :: FIVE  :: SIX   :: SEVEN :: EIGHT ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::    41 ::    41 ::    41 ::    41 ::    41 ::
::     1 ::     1 ::     1 ::     1 ::     1 ::
::     3 ::     3 ::     3 ::     3 ::     3 ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::     0 ::     0 ::     0 ::     0 ::     0 ::
::     3 ::     3 ::     3 ::     3 ::     3 ::
::     7 ::     7 ::     7 ::     7 ::     7 ::
::     0 ::     0 ::     0 ::     0 ::     0 ::
::    59 ::    96 ::    92 ::    94 ::   100 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::   113 ::   151 ::   147 ::   149 ::   154 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::    72 ::    24 ::     0 ::     0 ::     0 ::
::   300 ::   300 ::     0 ::     0 ::     0 ::
::       ::       ::       ::       ::       ::
::    40 ::    35 ::    30 ::    25 ::    20 ::
::    30 ::    30 ::    30 ::    30 ::    30 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::   442 ::   389 ::    60 ::    55 ::    50 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
::       ::       ::       ::       ::       ::
::     0 ::     0 ::   145 ::   244 ::   243 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::  -178 ::  -186 ::  -367 ::  -263 ::  -255 ::
::       ::       ::       ::       ::       ::
::   755 ::   569 ::   202 ::   -61 ::  -316 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
                                             ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
```

STANDARD FARM MODEL

DEBT -A

DEBT SERVICING CALCULATIONS (all dollar values x 1000)

YEAR	ONE				TOTAL	TWO				TOTAL	THREE				TOTAL
QUARTER	1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH	
SHORT TERM LOANS:															
New loans	0	0	0	0	0	300	300	300	0	900					
Principal remaining	0	0	0	0	0	300	600	900	900	900	825	750	675	600	600
Principal payment					300					0	75	75	75	75	300
Interest payment	0.0	0.0	0.0	0.0	0	12.0	24.0	36.0	36.0	108	36.0	33.0	30.0	27.0	126
DEBT SERVICE	0	0	0	0	0	12	24	36	36	108	111	108	105	102	426
LONG TERM LOANS:															
New loans	0	0	0	0	0	0	0	0	300	300					
Principal remaining	0	0	0	0	0	0	0	0	293	293	285	278	270	263	263
Principal payment	0	0	0	0	0	0	0	0	8	8	8	8	8	8	30
Interest payment	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	12.0	12	11.7	11.4	11.1	10.8	45
DEBT SERVICE	0	0	0	0	0	0	0	0	20	20	19	19	19	18	75

DEBT-B

```
:: FOUR  :: FIVE  :: SIX   :: SEVEN :: EIGHT ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::   300 ::     0 ::     0 ::     0 ::     0 ::
::   300 ::   300 ::     0 ::     0 ::     0 ::
::  72.0 ::  24.0 ::   0.0 ::   0.0 ::   0.0 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::   372 ::   324 ::     0 ::     0 ::     0 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::   233 ::   203 ::   173 ::   143 ::   113 ::
::    30 ::    30 ::    30 ::    30 ::    30 ::
::  39.6 ::  34.8 ::  30.0 ::  25.2 ::  20.4 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::    70 ::    65 ::    60 ::    55 ::    50 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
```

STANDARD FARM MODEL

CAPITAL-A

CAPITAL COST ALLOWANCE (C.C.A.) CALCULATIONS (All dollar values x 1000)

YEAR	ONE				TOTAL	TWO				TOTAL	THREE				TOTAL
QUARTER	1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH	
Total purchases	157	400	570	590	590	699	775	909	1022	1022	1074	1075	1075	1076	1076
New purchases	157	243	170	19	590	109	76	134	113	432	52	1	1	1	54
Old purchases					0					516					765
Undeprec. balance	157	400	570	590	516	625	701	835	948	765	817	818	819	819	621
C.C.A.	(only 1/2 of normal rate, in year of purchase)			74	74				183	183				198	198

```
                                   CAPITAL-B



:: FOUR  :: FIVE  :: SIX   :: SEVEN :: EIGHT ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::  1109 ::  1340 ::  1407 ::  1635 ::  1790 ::
::       ::       ::       ::       ::       ::
::   113 ::   151 ::   147 ::   149 ::   154 ::
::   621 ::   565 ::   556 ::   545 ::   539 ::
::   565 ::   556 ::   545 ::   539 ::   539 ::
::       ::       ::       ::       ::       ::
::   170 ::   160 ::   157 ::   155 ::   154 ::
::       ::       ::       ::       ::       ::
::       ::       ::
```

STANDARD FARM MODEL

INCOME-A

INCOME STATEMENT (all dollar values x 1000)

YEAR	ONE				TOTAL	TWO				TOTAL	THREE				TOTAL
QUARTER	1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH		1ST	2ND	3RD	4TH	
REVENUES:	0	0	0	0	0	0	0	877	0	877	743	1448	877	0	3068
COST OF GOODS SOLD:	8	177	50	83	318	114	382	586	260	1341	463	727	586	260	2036
GROSS PROFIT	-8	-177	-50	-83	-318	-114	-382	291	-260	-464	280	721	291	-260	1033
OVERHEAD:															
FIXED COSTS:	58	24	27	31	140	46	58	64	73	242	84	73	67	74	298
INTEREST CHARGES:	0	0	0	0	0	12	24	36	48	120	48	44	41	38	171
C.C.A.				74	74				183	183				198	198
NET PROFIT	-66	-201	-77	-187	-531	-172	-464	191	-564	-1009	148	604	183	-569	366
TAXES:					0					0					0
LOSSES CARRIED FRWD.	-66	-267	-344	-531	-531	-703	-1167	-976	-1540	-1540	-1392	-788	-605	-1174	-1174
PROFIT AFTER TAX					0					0					366

```
                                   INCOME-B


:: FOUR  :: FIVE  :: SIX   :: SEVEN :: EIGHT ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::  3068 ::  3068 ::  3068 ::  3068 ::  3068 ::
::       ::       ::       ::       ::       ::
::  2036 ::  2036 ::  2036 ::  2036 ::  2036 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::  1033 ::  1033 ::  1033 ::  1033 ::  1033 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
::       ::       ::       ::       ::       ::
::       ::       ::       ::       ::       ::
::   300 ::   307 ::   314 ::   322 ::   329 ::
::   112 ::    59 ::    30 ::    25 ::    20 ::
::   170 ::   160 ::   157 ::   155 ::   154 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::   452 ::   507 ::   531 ::   531 ::   529 ::
:: ----- :: ----- :: ----- :: ----- :: ----- ::
::       ::       ::       ::       ::       ::
::     0 ::     0 ::   145 ::   244 ::   243 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
::  -722 ::  -216 ::     0 ::     0 ::     0 ::
::       ::       ::       ::       ::       ::
::   452 ::   507 ::   386 ::   287 ::   286 ::
:: ===== :: ===== :: ===== :: ===== :: ===== ::
```